NBS
Publi-
cations

NAT'L INST. OF STAND & TECH R.I.C.
A11104 937819

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL ELECTRICAL SAFETY CODE

NATIONAL BUREAU OF STANDARDS HANDBOOK H30

C
17/5/48

U.S. BUREAU
OF
STANDARDS
LIBRARY

U. S. DEPARTMENT OF COMMERCE
W. AVERELL HARRIMAN, Secretary
NATIONAL BUREAU OF STANDARDS
EDWARD U. CONDON, Director

National Bureau of Standards Handbook H30
[Supersedes H3]

NATIONAL ELECTRICAL SAFETY CODE

Grounding Rules and Parts I, II, III, IV, and V

Issued March 1948

Approved by the American Standards Association:
Parts I and III, May 8, 1941
Part II, August 27, 1941
Part IV, August 10, 1939
Part V, May 29, 1940

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1948

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price $1.25

National Bureau of Standards
MAY 1 3 1948
63136

PREFACE

This handbook contains the first five parts of the fifth edition of the National Electrical Safety Code. Each of these parts has been approved by the American Standards Association as an American Standard. Part 6 of the code has not been included as it is being revised under a new and separate sectional committee.

Parts 1 to 5, inclusive, of the National Electrical Safety Code were revised separately by technical committees working under the Sectional Committee listed in this handbook. These parts have been issued separately as National Bureau of Standards Handbooks H31 to H35, inclusive. This volume combines these Handbooks under one cover. The page numbers of the separate Handbooks have been retained to assist in the location of specific code rules regardless of the volume used. They appear in the caption at the inner or binding edge of each page.

In preparation of the first few editions of the code, the Bureau held meetings in many parts of the country and welcomed suggestions from everyone concerned. It, however, reserved to itself the final decision on all contested points. The procedure followed in later revisions subsequent to the establishment of the American Standards Association differs essentially from the former practice in that final decisions as to all details are made by the sectional committees formally approved by the American Standards Association and operating under their rules of procedure. The Bureau, as sponsor for the work under this procedure, has given up its prerogative of determining details in return for the implied understanding that the many parties concerned will accept such a code as they can agree upon among themselves. All such codes of practice necessarily include compromises between conflicting aims. The Bureau has felt that decisions made by practically unanimous agreement among the interests affected would, in general, be wiser than those at which it might arrive after weighing the arguments of advocates for different views. It has, therefore, welcomed this procedure in spite of the fact that this involves the acceptance of some details of which it might not itself approve.

Rules in this code which are to be regarded as mandatory are characterized by the use of the word "shall." Where a rule is of an advisory nature it is indicated by the use of the word "should." Other practices which are considered desirable and not intended to be mandatory are stated as recommendations. It is realized that conditions may exist which necessitate departures from such recommendations.

Criticism of the rules and suggestions for their improvement are invited especially from those who have experience in the practical application. In future editions every effort will be made to perfect the rules, both in the development of detail and in the modification of any requirements which it is found can be improved.

A widely representative Committee on Interpretations has been set up to prepare replies to requests for interpretation of these rules. Such requests addressed to the National Bureau of Standards will be sent to this committee promptly and the inquirer notified of their decision.

A discussion of Part 2 of the fifth edition of the National Electrical Safety Code has been prepared and issued as National Bureau of Standards Handbook H39. Discussions of the other parts of the code are contemplated.

E. U. Condon, *Director.*

SECTIONAL COMMITTEE

Chairman, J. A. Dickinson [1]
Vice Chairman, C. B. Hayden
Secretary, A. B. Campbell

Organization represented	*Name and business affiliation*
American Institute of Electrical Engineers.	T. H. Haines, Edison Electric Illuminating Company of Boston.
American Mutual Alliance.	S. E. Whiting, Liberty Mutual Insurance Co.
American Society of Safety Engineers—Engineering Section of National Safety Council.	Roy M. Godwin, Philadelphia Electric Co. W. Dean Keefer (alternate), National Safety Council.
American Transit Association.	Charles Rufus Harte, Connecticut Co. W. J. Quinn (alternate), Third Avenue Railway System, N. Y. C.
Association of American Railroads.	Sidney Withington, New York, New Haven & Hartford Railroad. W. R. Triem (alternate), Pennsylvania Railroad.
Association of Edison Illuminating Companies.	W. C. Wagner, Philadelphia Electric Co. B. C. Sherwood (alternate), Commonwealth Edison Co.
Edison Electric Institute.	W. G. Kelley, Commonwealth Edison Co. A. B. Campbell (alternate), Edison Electric Institute.
Fire Protection Group.	A. R. Small, Underwriters' Laboratories, Inc.
International Association of Electrical Inspectors.	W. J. Mahan, New Haven Building Department. F. N. M. Squires (alternate), New York Board of Fire Underwriters.
International Association of Governmental Labor Officials.	Geo. P. Keogh, New York Department of Labor. Max D. Kossoris (alternate), U. S. Department of Labor.
International Association of Industrial Accident Boards and Commissions.	C. George Krueger, New Jersey Department of Labor. G. E. Kimball (alternate), California Industrial Commission.

---

[1] Replaced M. G. Lloyd, deceased.

Organization rdpresented	*Name and business affiliation*
International Brotherhood of Electrical Workers.	William F. Kelly, International Brotherhood of Electrical Workers.
International Municipal Signal Association.	W. J. Canada, Consulting Engineer.
	H. A. Friede (alternate), Government of the District of Columbia.
National Association of Railroad and Utilities Commissioners.	Stuart Purcell, Maryland Public Service Commission.
	F. T. McNamara (alternate), Yale University.
National Bureau of Casualty and Surety Underwriters.	H. W. Heinrich, Travelers Insurance Co.
	C. R. Chace (alternate), Travelers Insurance Co.
National Bureau of Standards.	J. A. Dickinson,[1] National Bureau of Standards.
National Electrical Contractors' Association.	C. W. Mosely, R. H. Bouligny, Inc.
National Electrical Manufacturers' Association.	L. F. Adams, General Electric Co.
	Frank Thornton, Jr., Westinghouse Electric & Manufacturing Co.
Public Service Commission of New York.	R. H. Nexsen, Public Service Commission of New York.
Public Service Commission of Wisconsin.	C. B. Hayden, Public Service Commission of Wisconsin.
Telegraph Group.	D. P. Dickie, Western Union Telegraph Co.
	C. S. Cummings (alternate), Western Union Telegraph Co.
Telephone Group.	H. L. Huber [2] American Telephone & Telegraph Co.
	J. T. Binford [2] (alternate), American Telephone & Telegraph Co.

---

[1] Replaced M. G. Lloyd, deceased.

[2] Deceased.

CONTENTS

[A more detailed table of contents is given at the beginning of each part]

Page

Preface II

Members of the sectional committee IV

Sec. 1. Definitions 1

Sec. 9. Rules covering methods of protective grounding 13

Part. 1. Rules for the installation and maintenance of electrical supply stations 31

- Sec. 10. Protective arrangements of stations and substations 33
- Sec. 11. Protective arrangements of equipment 41
- Sec. 12. Rotating equipment 51
- Sec. 13. Storage batteries 56
- Sec. 14. Transformers, induction regulators, rheostats, ground detectors, and similar equipment 59
- Sec. 15. Conductors 62
- Sec. 16. Fuses, circuit-breakers, switches, and controllers 65
- Sec. 17. Switchboards 70
- Sec. 18. Lightning arresters 73

Part 2. Rules for the installation and maintenance of electric supply and communication lines 77

- Sec. 20. Scope, nature, and application of rules 93
- Sec. 21. General requirements applying to overhead and underground lines 94
- Sec. 22. Relations between various classes of lines 98
- Sec. 23. Clearances 104
- Sec. 24. Grades of construction 153
- Sec. 25. Loading for grades B, C, and D 161
- Sec. 26. Strength requirements 168
- Sec. 27. Line insulators 208
- Sec. 28. Miscellaneous requirements 213
- Sec. 29. Rules for underground lines 230

Part 3. Rules for the installation and maintenance of electric utilization equipment 243

- Sec. 30. Scope of rules and general requirements 247
- Sec. 31. Conductors 255
- Sec. 32. Fuses, circuit-breakers, switches, and controllers 261
- Sec. 33. Switchboards and panelboards 277
- Sec. 34. Motors and motor-driven machinery 281
- Sec. 35. Electric furnaces, storage batteries, transformers, and lightning arresters 284
- Sec. 36. Lighting fixtures and signs 286
- Sec. 37. Portable applicances, cables and connectors, and insect eliminators 289
- Sec. 38. Electrically operated industrial locomotives, cars, cranes, hoists, and elevators 294
- Sec. 39. Telephone and other communication apparatus on circuits exposed to supply lines or lightning 300

Page
Part 4. Rules for the operation of electric equipment and lines 305
Sec. 40. Scope and application 307
Sec. 41. Supply systems—Rules for employers 308
Sec. 42. Supply systems—General rules for all employees 313
Sec. 43. Supply systems—Rules for employees doing specialized work 331
Sec. 44. Communication systems—Rules for employers 347
Sec. 45. Communication systems—Rules for employees 349
Part 5. Rules for radio installations 359
Sec. 50. Scope 361
Sec. 51. Classification of radio stations 361
Sec. 52. Antenna and counterpoise installation 362
Sec. 53. Lead-in conductors 370
Sec. 54. Construction at building entrance 373
Sec. 55. Protective devices 374
Sec. 56. Protective and operating grounding conductors 375
Sec. 57. Grounds and ground connections 376
Sec. 58. Connection to power supply lines 378
Sec. 59. Batteries 379
Index 381

NATIONAL ELECTRICAL SAFETY CODE

SEC. 1. DEFINITIONS OF SPECIAL TERMS

Alphabetical List of Defined Terms

Terms	Definition No.	Page
Alive or live	1	2
Appliance	2	2
Automatic	3	2
Cable vault	4	2
Circuit	5	2
Circuit-breaker	6	2
Climbing space	7	2
Common use	8	2
Conductor	9	2
Grounding conductor	10	2
Lateral conductor	11	2
Line conductor	12	2
Vertical conductor	13	3
Conflict:		
Antenna conflict	14	3
Conductor conflict	15	3
Structure conflict	16	4
Current-carrying part	17	4
Dead	18	4
Device	19	4
Disconnector	20	4
Duct	21	5
Electric fence	22	5
Electric-fence wire	23	5
Electrical supply station	24	5
Equipment	25	6
Electric-supply equipment	26	6
Utilization equipment	27	6
Explosion proof	28	6
Exposed:		
Applied to circuits or lines	29	6
Applied to equipment	30	6
Externally operable	31	6
Grounded	32	6
Effectively grounded	33	7
Grounded system	34	7
Guarded	35	7
Handhole	36	7
Inclosed	37	7
Insulated	38	7
Insulating	39	7
Isolated	40	7
Isolation by elevation	41	8
Joint use	42	8
Lateral working space	43	8
Lightning arrester	44	8
Lines:		
Communication lines	45	8
Minor communication lines	46	8
Electric-supply lines	47	8
Low-voltage protection	48	9
Low-voltage release	49	9
Manhole	50	9
Manual	51	9
Minor tracks	52	9
Open wire	53	9
Panelboard	54	9
Qualified	55	10
Raceway	56	10
Reconstruction	57	10
Rural districts	58	10
Sag:		
Apparent sag at any point	59	10
Apparent sag of a span	60	10
Final unloaded sag	61	10
Initial unloaded sag	62	10
Maximum total sag	63	10
Total sag	64	10
Unloaded sag of a conductor	65	10
Service	66	11
Span length	67	11
Splicing chamber	68	11
Substantial	69	11
Switch	70	11
Switchboard	71	11
Tags	72	11
Tension:		
Final unloaded conductor tension	73	11
Initial conductor tension	74	11
Transformer vault	75	11
Urban districts	76	12
Voltage:		
Voltage of a circuit	77	12
Voltage to ground of:		
A grounded circuit	78	12
An ungrounded circuit	79	12
Voltage to ground of a conductor:		
Of a grounded circuit	80	12
Of an ungrounded circuit	81	12
Wire gages	82	12

1. **Alive** or **live** means electrically connected to a source of potential difference, or electrically charged so as to have a potential different from that of the earth. The term "live" is sometimes used in place of the term "current-carrying," where the intent is clear, to avoid repetitions of the longer term.

2. **Appliance** means current-consuming equipment, fixed or portable; for example, heating, cooking, and small motor-operated equipment.

3. **Automatic** means self-acting, operating by its own mechanism when actuated by some impersonal influence—as, for example, a change in current strength; not manual, without personal intervention. Remote control that requires personal intervention is not automatic, but manual.

4. **Cable vault.** (See definition of "Manhole.")

5. **Circuit** means a conductor or system of conductors through which an electric current is intended to flow.

6. **Circuit-breaker** means a device designed to open under abnormal conditions a current-carrying circuit without injury to itself. The term as used in this code applies only to the automatic type designed to trip on a predetermined overload of current.

7. **Climbing space** means the vertical space reserved along the side of a pole structure to permit ready access for linemen to equipment and conductors located on the pole structure.

8. **Common use** means simultaneous use by two or more utilities of the same kind.

9. **Conductor** means a metallic conducting material, usually in the form of a wire or cable, suitable for carrying an electric current. Does not include bus bars.

 10. **Grounding conductor** means a conductor which is used to connect the equipment or the wiring system with a grounding electrode or electrodes.

 11. **Lateral conductor** means, in pole wiring work, a wire or cable extending in a general horizontal direction approximately at right angles to the general direction of the line conductors.

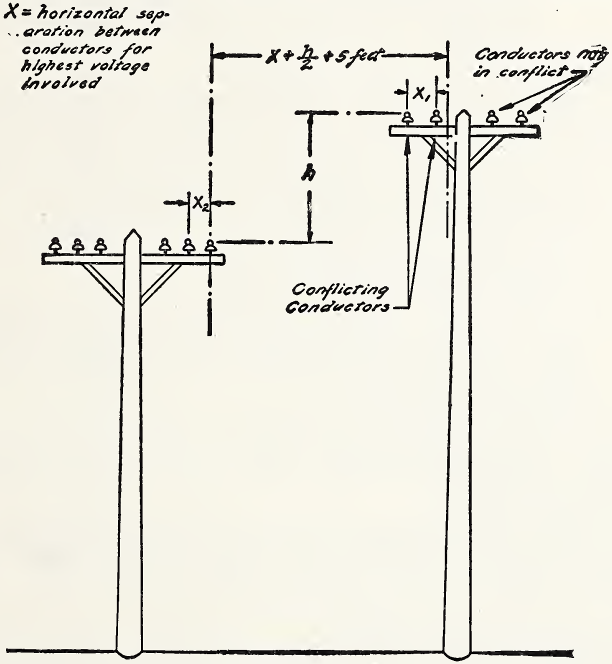
 12. **Line conductor** means one of the wires or cables carrying electric current, supported by poles, towers, or

other structures, but not including vertical or lateral connecting wires.

13. Vertical conductor means, in pole wiring work, a wire or cable extending in an approximately vertical direction.

Conflict:

14. Antenna conflict means that an antenna or its guy wire is at a higher level than a supply or communication conductor and approximately parallel thereto, provided the breaking of the antenna or its support will be likely to result in contact between the antenna or guy wire and the supply or communication conductor.


X = horizontal separation between conductors for highest voltage involved
X + h/2 + 5 feet
Conductors not in conflict
X₁
h
X₂
Conflicting Conductors

Conductor Conflict

15. Conductor conflict means that a conductor is so

situated with respect to a conductor of another line at a lower level that the horizontal distance between them is less than the sum of the following values:

(a) Five feet.

(b) One-half the difference of level between the conductors concerned.

(c) The value required in tables 6, 7, or 8 for horizontal separation between conductors on the same support for the highest voltage carried by either conductor concerned. (See illustration.)

16. **Structure conflict** (as applied to a pole line) means that the line is so situated with respect to a second line that the overturning (at the ground line) of the first line will result in contact between its poles or conductors and the conductors of the second line, assuming that no conductors are broken in either line. (See illustration.)

Exceptions: Lines are not considered as conflicting under the following conditions:

(1) Where one line crosses another.

(2) Where two lines are on opposite sides of a highway, street, or alley and are separated by a distance not less than 60 percent of the height of the taller pole line and not less than 20 feet.

17. **Current-carrying part** means a conducting part intended to be connected in an electric circuit to a source of voltage. Noncurrent-carrying parts are those not intended to be so connected.

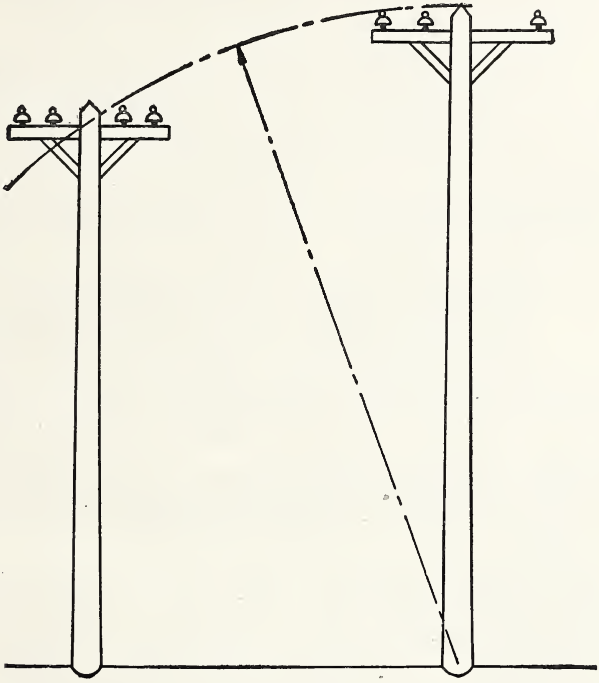
18. **Dead** means free from any electric connection to a source of potential difference and from electric charge; not having a potential different from that of the earth. The term is used only with reference to current-carrying parts which are sometimes alive.

19. **Device** means a unit of an electric wiring system which is intended to carry but not consume electric energy.

20. **Disconnector** means a switch which is intended to open a circuit only after the load has been thrown off by some other means.

Note: Manual switches designed for opening loaded circuits are usually installed in circuit with disconnectors, to provide a safe means for opening the circuit under load.

21. **Duct** means (in underground work) a single tubular runway for underground cables.



Structure Conflict

22. **Electric fence** means a barrier to animals or fowls, consisting of an electrified conductor energized through an electric-fence controller.

23. **Electric-fence wire** means any electrified conductor, such as a wire, ribbon, tape, rod, tube, plate, mesh, or any other form suitable for, and used as, a barrier to animals or fowls.

24. **Electrical supply station** means any building, room, or separate space within which electric-supply equipment is

located and the interior of which is accessible, as a rule, only to properly qualified persons.

Note: This includes generating stations and substations and generator, storage-battery, and transformer rooms, but excludes manholes and isolated-transformer vaults on private premises. (See definition of "transformer vault".)

25. **Equipment** means a general term including fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electric installation.

26. **Electric-supply equipment** means equipment which produces, modifies, regulates, controls, or safeguards a supply of electric energy. Similar equipment, however, is not included where used in connection with signaling systems under the following conditions:

(a) Where the voltage does not exceed 150.

(b) Where the voltage is between 150 and 400 and the power transmitted does not exceed 3 kilowatts.

27. **Utilization equipment** means equipment, devices, and connected wiring which utilize electric energy for mechanical, chemical, heating, lighting, testing, or similar purposes and are not a part of supply equipment, supply lines, or communication lines.

28. **Explosion-proof** means capable of withstanding without injury and without transmitting flame to the outside any explosion of gas which may occur within.

Exposed:

29. **Applied to circuits or lines** means in such a position that in case of failure of supports or insulation contact with another circuit or line may result.

30. **Applied to equipment** means that an object or device can be inadvertently touched or approached nearer than a safe distance by any person. It is applied to objects not suitably guarded or isolated.

31. **Externally operable** means capable of being operated without exposing the operator to contact with live parts.

Note: This term is applied to equipment, such as a switch, that is inclosed in a case or cabinet.

32. **Grounded** means connected to earth or to some extended conducting body which serves instead of the earth, whether the connection is intentional or accidental.

33. **Effectively grounded** means permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient current-carrying capacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons.

34. **Grounded system** means a system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current-limiting device.

35. **Guarded** means covered, shielded, fenced, inclosed, or otherwise protected, by means of suitable covers or casings, barrier rails or screens, mats or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

36. **Handhole** means an opening in an underground system into which workmen reach, but do not enter.

37. **Inclosed** means surrounded by a case which will prevent accidental contact of a person with live parts. A solid inclosure means one which will neither admit accumulations of flyings or dust, nor transmit sparks or flying particles to the accumulations outside.

38. **Insulated** means separated from other conducting surfaces by a dielectric substance or air space permanently offering a high resistance to the passage of current and to disruptive discharge through the substance or space.

Note: When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise, it is, within the purpose of these rules, uninsulated. Insulating covering of conductors is one means for making the conductors insulated.

39. **Insulating** (where applied to the covering of a conductor, or to clothing, guards, rods, and other safety devices) means that a device, when interposed between a person and current-carrying parts, protects the person making use of it against electric shock from the current-carrying parts with which the device is intended to be used; the opposite of conducting.

40. **Isolated** means that an object is not readily accessible to persons unless special means for access are used.

41. **Isolation by elevation** means elevated sufficiently so that persons may safely walk underneath.

42. **Joint use** means simultaneous use by two or more kinds of utilities.

43. **Lateral working space** means the space reserved for working between conductor levels outside the climbing space, and to its right and left.

44. **Lightning arrester** means a device which has the property of reducing the voltage of a surge applied to its terminals, is capable of interrupting follow current if present, and restores itself to its original operating conditions.

Lines:

45. **Communication lines** means the conductors and their supporting or containing structures which are located outside of buildings and are used for public or private signal or communication service, and which operate at not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. When operating at less than 150 volts no limit is placed on the capacity of the system.

Note: Telephone, telegraph, railroad-signal, messenger-call, clock, fire or police-alarm and other systems conforming with the above are included.

Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so run.

Exception is made under certain conditions for communication circuits used in the operation of supply lines. (See rule 288, A).

46. **Minor communication lines** means communication lines carrying not more than two circuits used mainly for local telephone or telegraph service, or for police or fire-alarm service.

47. **Electric-supply lines** means those conductors and their necessary supporting or containing structures which are located entirely outside of buildings and are used for transmitting a supply of electric energy.

Does not include open wiring on buildings, in yards or similar locations where spans are less than 20 feet, and all the precautions required for stations or utilization equipment, as the case may be, are observed.

Railway signal lines of more than 400 volts to ground are always supply lines within the meaning of these rules, and those of less than 400 volts may be considered as supply lines, if so run and operated throughout.

48. **Low-voltage protection** means the effect of a device operative on the reduction or failure of voltage to cause and maintain the interruption of power supply to the equipment protected.

49. **Low-voltage release** means the effect of a device operative on the reduction or failure of voltage to cause the interruption of power supply to the equipment, but not preventing the reestablishment of the power supply on return of voltage.

50. **Manhole** (more accurately termed **splicing chamber** or **cable vault**) means an opening in an underground system which workmen or others may enter for the purpose of installing cables, transformers, junction boxes, and other devices, and for making connections and tests.

51. **Manual** means capable of being operated by personal intervention.

52. **Minor tracks** means railway tracks included in the following list:

(a) Spurs less than 2,000 feet long and not exceeding two tracks in the same span.

(b) Branches on which no regular service is maintained or which are not operated during the winter season.

(c) Narrow-gage tracks or other tracks on which standard rolling stock can not, for physical reasons, be operated.

(d) Tracks used only temporarily for a period not exceeding 1 year.

(e) Tracks not operated as a public utility, such as industrial railways used in logging, mining, etc.

53. **Open wire** means a conductor or pair of conductors separately supported above the surface of the ground.

54. **Panelboard** means a single panel, or a group of panel units designed for assembly in the form of a single panel, including buses and with or without switches and/or automatic overcurrent-protective devices for the control of light, heat, or power circuits of small individual as well as aggre-

gate capacity; designed to be placed in a cabinet or cut-out box placed in or against a wall or partition, and accessible only from the front. (See definition of "Switchboard.")

55. **Qualified** means familiar with the construction and operation of the apparatus and the hazards involved.

56. **Raceway** means any channel for loosely holding wires or cables in interior work, which is designed expressly and used solely for this purpose. Raceways may be of metal, wood, or insulating material, and the term includes wood and metal moldings consisting of a backing and capping, and also metal ducts into which wires are to be pulled.

57. **Reconstruction** means replacement of any portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

58. **Rural districts** means all places not urban, usually in the country, but in some cases within city limits.

Sag:

59. **Apparent sag at any point** means the departure of the wire at the particular point in the span from the straight line between the two points of support of the span, at 60° F, with no wind loading.

60. **Apparent sag of a span** means the maximum departure of the wire in a given span from the straight line between the two points of support of the span, at 60° F, with no wind loading.

61. **Final unloaded sag** means the sag of a conductor after it has been subjected for an appreciable period to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed.

62. **Initial unloaded sag** means the sag of a conductor prior to the application of any external load.

63. **Maximum total sag** means the total sag at the midpoint of the straight line joining the two points of support of the conductor.

64. **Total sag** means the distance measured vertically from any point of a conductor to the straight line joining its two points of support, under conditions of ice loading equivalent to the total resultant loading for the district in which it is located.

65. **Unloaded sag of a conductor at any point in a span** means the distance measured vertically from the parti-

cular point in the conductor to a straight line between its two points of support, without any external load.

66. **Service** means the conductors and equipment for delivering electric energy from the secondary distribution or street main, or other distribution feeder, or from the transformer, to the wiring system of the premises served. For overhead circuits, it includes the conductors from the last line pole to the service switch or fuse. The portion of an overhead service between the pole and building is designated as "service drop."

67. **Span length** means the horizontal distance between two adjacent supporting points of a conductor.

68. **Splicing chamber.** (See definition of "Manhole.")

69. **Substantial** means so constructed and arranged as to be of adequate strength and durability for the service to be performed under the prevailing conditions.

70. **Switch** means a device for opening and closing or for changing the connection of a circuit. In these rules, a switch will always be understood to be manually operated, unless otherwise stated.

71. **Switchboard** means a large single panel, frame, or assembly of panels, on which are mounted (on the face, or back, or both) switches, fuses busses, and usually instruments.

72. **Tags** means "men at work" tags of distinctive appearance, indicating that the equipment or lines so marked are being worked on.

Tension:

73. **Final unloaded conductor tension** means the longitudinal tension in a conductor after the conductor has been stretched by the application for an appreciable period, and subsequent release, of the loadings of ice and wind, and temperature decrease, assumed for the loading district in which the conductor is strung (or equivalent loading).

74. **Initial conductor tension** means the longitudinal tension in a conductor prior to the application of any external load.

75. **Transformer vault** means an isolated inclosure either above or below ground with fire-resistant walls, ceiling, and floor, in which transformers and related equipment are

installed, and which is not continuously attended during operation.

76. **Urban districts** means thickly settled areas (whether in cities or suburbs) or where congested traffic often occurs. A highway, even though in the country, on which the traffic is often very heavy, is considered as urban.

Voltage:

77. **Voltage of a circuit** means the highest effective voltage between any two conductors of the circuit concerned.

Exception: Voltage of a grounded multiwire circuit, not exceeding 750 volts between any two conductors, means the highest effective voltage between any wire of the circuit and that point or conductor of the circuit which is grounded.

If one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

Voltage to ground of:

78. **A grounded circuit** means the highest effective voltage between any conductor of the circuit and that point or conductor of the circuit which is grounded.

79. **An ungrounded circuit** means the highest effective voltage between any two conductors of the circuit concerned.

Voltage to ground of a conductor of:

80. **A grounded circuit** means the highest effective voltage between such conductor and that point or conductor of the circuit which is grounded.

81. **An ungrounded circuit** means the highest effective voltage between such conductor and any other conductor of the circuit concerned.

82. **Wire gages:** The American Wire Gage (AWG), otherwise known as Brown & Sharpe (B&S), is the standard gage for copper, aluminum, and other conductors, excepting steel, for which the Steel Wire Gage (Stl. WG) is used throughout these rules.

SEC. 9. RULES COVERING METHODS OF PROTECTIVE GROUNDING OF CIRCUITS, EQUIPMENT, AND LIGHTNING ARRESTERS FOR STATIONS, LINES, AND UTILIZATION EQUIPMENT

CONTENTS

Page

90. Scope of the rules ---- 15
91. Application of the rules ---- 15
    A. Waiving rules ---- 15
    B. Application ---- 15
    C. Temporary installations ---- 16
    D. Emergency ---- 16
92. Point of attachment of grounding conductor ---- 16
    A. Direct-current distribution systems ---- 16
    B. Alternating-current distribution systems ---- 16
    C. Current in grounding conductor ---- 17
    D. Equipment and wire raceways ---- 18
    E. Service conduit ---- 18
93. Grounding conductor ---- 18
    A. Material and continuity ---- 18
    B. Size and capacity ---- 19
        1. For direct-current circuits ---- 19
        2. For alternating-current circuits ---- 19
        3. For instrument transformers ---- 19
        4. For lightning arresters ---- 19
        5. For raceways and equipment ---- 20
        6. For portable and pendent equipment ---- 20
    C. Mechanical protection and guarding against contact ---- 20
    D. Underground ---- 21
    E. Common grounding conductor for circuits, metal raceways, and equipment ---- 22
94. Ground connections ---- 22
    A. Piping systems ---- 22
    B. Alternate methods ---- 23
    C. Artificial grounds ---- 23
    D. Grounds to railway returns ---- 24
95. Method ---- 24
    A. Piping ---- 24
    B. Ground clamps ---- 25
    C. Contact surfaces ---- 25
    D. Electrodes for artificial grounds ---- 26

Page
96. Ground resistance 27
    A. Limits 27
    B. Checking 27
97. Separate grounding conductors and grounds 27
    A. Grounding conductors 27
    B. Electrodes 28
    C. Interconnection of primary arrester and secondary neutral 28
        1. Solid interconnection 28
        2. Interconnection through spark gap 29

90. SCOPE OF THE RULES.

The following rules apply to the grounding of all lightning arresters except those on communication circuits, and of all circuits, equipment, or wire raceways when the grounding is intended to be a permanent and effective protective measure.

They do not apply to the grounded return of electric railways, nor to the grounding of lightning protection wires which are independent of electric circuits or equipment.

These rules do not require that grounding shall be done, but cover the methods for protective grounding. The rules requiring grounding, in accordance with the methods specified below, are included under the various parts of this code.

Other methods of construction and installation than those specified in the rules may be used as experiments to obtain information if done where supervision can be given by the proper administrative authority.

91. APPLICATION OF THE RULES.

A. Waiving Rules.

The rules are intended to apply to all installations except as modified or waived by the proper administrative authority or its authorized agents. They are intended to be so modified or waived in particular cases wherever any rules are shown for any reason to be impracticable, such as by involving expense not justified by the protection secured; provided equivalent or safer construction is secured in other ways.

B. Application.

The intent of the rules will be realized (1) by applying the rules in full to all new installations, reconstructions, and extensions, except where any rule is shown to be impracticable for special reasons or where the advantage of uniformity with existing

91. B. Application—Continued.

construction is greater than the advantage of construction in compliance with the rules, provided the existing construction is reasonably safe; (2) by placing grounds on existing installations or bringing present grounds into compliance with the rules, except where the expense involved is not justifiable. The time allowed for bringing existing installations into compliance with the rules will be determined by the proper administrative authority.

C. Temporary Installations.

It will sometimes be necessary to modify or waive certain of the rules for specified limited periods of time in case of temporary installations or installations which are shortly to be dismantled or reconstructed.

D. Emergency.

In cases of emergency or pending decision of the administrator the person responsible for the installation may decide as to modification or waiver of any rule, subject to review by proper authority.

92. POINT OF ATTACHMENT OF GROUNDING CONDUCTOR.

A. Direct-Current Distribution Systems.

Direct-current systems which are to be grounded shall have the grounding connection made at one or more supply stations but not at individual services and not elsewhere on interior wiring. In three-wire direct-current systems the ground connections shall be made on the neutral.

B. Alternating-Current Distribution Systems.

In alternating-current systems the ground connection shall be made at the building service or near the transformer (or transformers) either by direct ground connection (through water-piping system or artificial ground, see rule 94) or by the use of a system ground wire to which are connected the grounded conductors of many secondary mains and which is itself effectually grounded at intervals that will fulfill, for any secondary utilizing the system

92. B. Alternating-Current Distribution Systems—Contd.

ground wire, the resistance and current-carrying requirements of these rules.

If the secondaries of transformers are supplying a common set of mains, fuses, if installed, shall be located only at such points as not to cause the loss of the ground connections after any fuses in the transformer circuits or mains have been blown.

Alternating-current secondary circuits supplied from a transformer outside the building shall not be grounded inside buildings except at the service entrance.

In single-phase, three-wire systems the ground shall be on the neutral conductor. In two-wire single-phase and in two-or three-phase systems the ground shall be made at that point of the system which brings about the lowest voltage from ground of unguarded current-carrying parts of connected devices. Where one phase of a two- or three-phase system is used for lighting, that phase should be grounded and at the neutral conductor, if one is used.

In the absence of direct grounds at all building services, ground connections shall be made to the grounded neutral or other grounded conductor of a secondary system supplying more than one utilization equipment, at intervals that will fulfill the resistance requirements of rule 96, A.

C. Current in Grounding Conductor.

Grounds shall be so arranged that under normal conditions of service there will be no objectionable flow of current over the grounding conductor.

The temporary currents set up under accidental conditions, while the grounding conductors are performing their intended protective functions, are not to be considered as objectionable.

If an objectionable flow of current occurs over a grounding conductor, due to the use of multiple grounds, (1) one or more of such grounds shall be abandoned, or (2) their location shall be changed;

92. C. Current in Grounding Conductor—Continued

or (3) the continuity of the conductor between the grounding connections shall be suitably interrupted, or (4) other means satisfactory to the administrative authority shall be taken to limit the current.

D. Equipment and Wire Raceways.

Metal boxes, cabinets and fittings, or non-current-carrying metal parts of other fixed equipment, if metallically connected to grounded cable armor or metal raceway, are considered to be grounded by such connection. Where the metal enclosure of a wiring system is used as part of the protective grounding, the electrical continuity of the enclosure shall be assured.

For conduit, armored cable, or metal raceways the ground connection shall be as near as practicable to the point where the conductors in the raceway system concerned receive their supply.

E. Service Conduit.

When the service conduit is grounded, its grounding wire shall be run directly from it to the ground connection. The interior conduit, armored cable, or metal raceways, if well bonded to the service conduit, grounded as provided in this rule, needs no additional ground connection.

93. GROUNDING CONDUCTOR.

A. Material and Continuity.

In all cases the grounding conductor shall be of copper or of other metal which will not corrode excessively under the existing conditions and, if practicable, shall be without joint or splice. If joints are unavoidable they shall be so made and maintained as to conform to the resistance requirements of rule 96.

In no case shall a fuse or automatic circuit-breaker be inserted in the grounding conductor or connection except in a ground connection from equipment where its operation will result in the automatic disconnection from all sources of energy of the circuit leads

93. A. Material and Continuity—Continued.

connected to equipment so grounded; no switch shall be so inserted except in plain sight, provided with distinctive marking and effectively isolated from unqualified persons. (See also rule 92, B, par. 2.)

For lightning arresters and ground detectors the grounding conductor shall be as short and straight as practicable and free from sharp bends.

B. **Size and Capacity.**

The grounding conductor shall conform to the following:

1. FOR DIRECT-CURRENT CIRCUITS.

A grounding conductor for a direct-current supply system shall have a current-carrying capacity not less than that of the largest conductor supplied by the system and in no case less than that of No. 8 copper.

2. FOR ALTERNATING-CURRENT CIRCUITS.

A grounding conductor for an alternating-current system shall have a current-carrying capacity not less than one-fifth that of the conductor to which it is attached and in no case less than that of No. 8 copper.

3. FOR INSTRUMENT TRANSFORMERS.

The grounding conductor for instrument cases and secondary circuits of instrument transformers shall not be smaller than No. 12 if of copper or, if of other metal, shall have equivalent current-carrying capacity.

4. FOR LIGHTNING ARRESTERS.

The grounding conductor or conductors shall have a current capacity sufficient to insure continuity and continued effectiveness of the ground connection under conditions of excess current caused by or following discharge of the arrester. No individual grounding conductor shall have less conductance than No. 6 (0.162-inch) copper wire.

93. B. Size and Capacity—Continued.

5. FOR RACEWAYS AND EQUIPMENT.

The current-carrying capacity of grounding conductors for equipment, raceways, cable armor, and other metal enclosures for wires, when provided with overcurrent protection, shall be sufficient to provide adequate draining of fault current during the time required for the protective device to operate. Where connected to artificial electrodes, the grounding conductor need not be larger than No. 6 copper wire or its equivalent. If no fuse or automatic circuit-breaker is provided, the capacity of the grounding conductor shall be determined by the design and operating conditions of the circuit, but shall not be smaller than No. 8.

6. FOR PORTABLE AND PENDENT EQUIPMENT.

For grounding portable or pendent equipment, the conductors to which are protected by fuses or circuit-breakers rated or set at not exceeding 15 amperes, No. 18 copper wire may be used. For grounding portable or pendent equipment protected at more than 15 amperes, see preceding paragraph.

C. Mechanical Protection and Guarding Against Contact.

Where exposed to mechanical injury, the grounding conductor shall be protected by substantial conduit or other guard. Guards for lightning-arrester grounding conductors shall be of nonmagnetic material unless the grounding conductor is electrically connected to both ends of the guard.

If the resistance of the ground connection is in excess of three ohms, the grounding conductor, except in rural districts, shall be protected and guarded by being inclosed in insulating conduit or

93. C. **Mechanical Protection and Guarding Against Contact.—Continued.**

molding to protect persons from injury by coming in contact with it.

Note: Such a high resistance may exist where artificial grounds are necessarily permitted in lieu of the preferable grounds to buried metallic water-piping systems.

Mechanical protection and insulating guards should extend for a distance of not less than 8 feet above any ground, platform, or floor from which grounding conductors are accessible to the public.

Note: Insulating mechanical protection is advisable for single arrester grounds, even when the connection is made to a water-piping system, and has therefore a low resistance, since a single connection is liable to be accidentally broken.

Even where ground connections have a resistance not exceeding that specified in rule 96 and no guard is therefore provided (or as an additional protection to persons even where guards are used), artificial grounds may be arranged to minimize the potential gradient along the surface of the earth by use of radial connecting wires underneath the earth surface or by other suitable means.

A grounding conductor for a circuit shall be guarded as required for current-carrying conductors of the circuit.

Exception 1: A grounding conductor for a circuit having at least two ground connections, where such conductor is entirely outside buildings and has strength and current capacity not less than No. 8 (0.1285-inch) copper wire.

Exception 2: In stations substantial bare ground busses may be used.

D. **Underground.**

Wires used for grounding conductors, if laid underground, shall, unless otherwise mechanically protected, be laid slack to prevent their being readily broken, and shall have joints carefully painted or otherwise protected against corrosion.

93. Grounding Conductor—Continued.

E. Common Grounding Conductor for Circuits, Metal Raceways, and Equipment.

The grounding conductor of an interior wiring system may be used also as the grounding conductor for equipment, conduit, and other metal raceways or enclosures for conductors, including service conduit or cable sheath and service equipment, provided such grounding conductor meets the current-carrying-capacity requirements for service raceways, as specified in paragraph B above; and provided further, that the secondary distribution circuit supplying the interior wiring system has at least one additional ground at the transformer or elsewhere.

94. GROUND CONNECTIONS.

The ground connection shall be permanent and effective, and be made as indicated below, but always to water-piping systems, if available.

A. Piping Systems.

For circuits, equipment, and arresters at supply stations, connections shall be made to all available active metallic underground water-piping systems between which no appreciable difference of potential normally exists, if the pipe is of sufficient capacity, and to one such system if appreciable differences of potential do exist between them. At other places connections shall be made to at least one such system, if available. Gas piping should be avoided for circuit grounding wherever practicable.

Note: The protective grounding of electric circuits and equipment to water-pipe systems in accordance with these rules should always be permitted, since such grounding offers the most effective protection to life and property and is not injurious to the piping systems.

Ground connections from circuits should not be made to jointed piping within buildings except water piping.

94. Ground Connections—Continued.

B. Alternate Methods.

Where underground metallic piping systems are not available, other methods which will secure the desired permanence and conductance may be permitted. In many cases metal well casings, and similar buried metal structures of considerable extent will be available and may be used in lieu of extended buried water-piping systems.

In some cases ground connection may be made to the steel frame of a building containing the grounded circuits or equipment, to which frames of machines and other noncurrent-carrying surfaces should also then be connected. In such cases the building frame should be itself well grounded by effective connection to the ground. This may require artificial grounding for steel-frame buildings supported on masonry or concrete footings.

C. Artificial Grounds.

If resort must be had to artificial grounds, their number should be determined by the following requirements:

1. Not more than one such ground is required for lightning arresters, except where for large current capacity.
2. At least two grounds are required for low-voltage alternating-current distribution circuits at transformers or elsewhere, except as specified in 3.
3. Where no part of the circuit or equipment protected can be reached by persons while they are standing on the ground or damp floors, or by persons while touching any metallic piping to which the grounding conductor is not effectively connected, a single artificial ground may be used even if its resistance exceeds that specified in rule 96. In such cases it is desirable to provide guards for the grounding conductor in accordance with rule 93, C, wherever it is otherwise accessible, or to provide insulating mats or platforms so located

94. C. Artificial Grounds—Continued.

that persons can not readily touch the grounding conductors without standing on such mats or platforms.

D. Grounds to Railway Returns.

Protective ground connections should not be made to railway negative-return circuits when other effective means of grounding are available, except ground connections from electric-railway lightning arresters.

When ground connections are of necessity made to the grounded track return of electric railways, they shall be made in such a manner as not to afford a metallic connection (as indirectly through a grounded neutral with multiple grounds) between the railway return and the other grounded conducting bodies (such as buried piping and cable sheaths).

Note: This rule does not prohibit the making of drainage connections (which are not protective grounds) between piping systems and railway negative-return circuits for the prevention of electrolysis.

Multiple protective ground connections from other circuits to railway returns should be avoided; and where multiple artificial grounds are made on such other circuits near such railway returns, they should be so arranged as to prevent the flow of any considerable current in and between such connections, which flow would reduce their effectiveness, or otherwise cause damage.

95. METHOD.

A. Piping.

The point of attachment of a grounding conductor to a water-piping system shall be on the street side of the water meter, or on a cold-water pipe of adequate current-carrying capacity, as near as practicable to the water-service entrance to the building or near the equipment to be grounded, and shall be accessible except by special permission. If the point of attachment is not on the street side of the water meter, the water-piping system shall be made electrically continuous by bonding together all parts between the attachment and the pipe entrance which

95. A. Piping—Continued.

are liable to become disconnected, as at meters and service unions. If water meters are located outside buildings or in concrete pits within buildings where piping connections are embedded in concrete flooring, the ground connections may be made on the building side of the meters.

Gas-piping systems within buildings shall not be used for purposes of this rule where water pipes are readily available. Gas piping may serve as the grounding electrode for fixtures located at a considerable distance from water piping. Where gas piping is so used it shall be bonded to the water-piping system at the point of entrance of water piping. (See rule 94, A.)

B. Ground Clamps.

The ground connection to metallic-piping systems shall be made by means of an approved clamp firmly bolted to the pipe after all rust and scale have been removed, or by means of a brass plug which has been tightly screwed into a pipe fitting or, where the pipe is of sufficient thickness, screwed into a hole in the pipe itself, or by other equivalent means.

The grounding conductor shall be attached to the clamp or to the plug by means of solder or by an approved solderless connector. The point of connection shall be as readily accessible as practicable.

Note: With bell-and-spigot-joint pipe it may be necessary to connect to several lengths where circuits or equipment of large current capacity are being grounded.

C. Contact Surfaces.

If conduit, couplings, or fittings having protective coating of nonconducting material, such as enamel, are used, such coating shall be thoroughly removed from threads of both couplings and conduit and such surfaces of fittings where the conduit or ground clamp is secured, in order to obtain the requisite good connection. Grounded pipes shall be free from rust, scale, etc., at the place of attachment of ground clamp.

95. C. Contact Surfaces—Continued.

Conduits, other metal raceways, and the armor of cables shall be securely fastened in outlet boxes, junction boxes, and cabinets, so as to secure good electrical connection.

In ice houses, packing plants, etc., where a great deal of moisture is present and where conduits are attached to metal cabinets, cut-out, pull, or junction boxes, compensators, etc., by means of lock nuts and bushings, these conduits should be bonded together.

D. Electrodes for Artificial Grounds.

Where artificial grounds are used, the electrodes shall, as far as practicable, be embedded below permanent moisture level.

Buried-plate electrodes shall present not less than 2 square feet of surface to exterior soil. Electrodes of plate copper shall be at least 0.06 inch in thickness. Electrodes of iron or steel plates shall be at least ¼ inch in thickness.

Electrodes of iron or steel pipe shall be galvanized and not less than ½ inch (nominal size). Electrodes of rods of steel or iron shall be at least ¾ inch minimum cross-sectional dimension. Approved rods of nonferrous materials or their approved equivalent used for electrodes shall be not less than ½ inch in diameter. Driven electrodes of pipes or rods, if of less than standard commercial length, shall preferably be of one piece, and, except where rock bottom is encountered, shall be driven to a depth of at least 8 feet regardless of size or number of electrodes used. Such pipes or rods shall have clean metal surfaces and shall not be covered with paint, enamel, or other poorly conducting materials.

Pole-grounding electrodes may be wire attached to the pole previous to the setting of the pole. The wire shall have a continuous length below ground level of not less than 12 feet, shall extend to the bottom of the pole, and shall be not smaller than No. 6 (0.162 inch).

96. GROUND RESISTANCE.

A. Limits.

The combined resistances of the grounding wire and the connection with the ground shall not exceed 3 ohms for water-pipe connections nor 25 ohms for artificial (buried or driven) grounds. Where it is impracticable to obtain, with one electrode, artificial-ground resistance as low as 25 ohms, this requirement shall be waived, and two or more electrodes, at least 6 feet apart, shall be provided.

B. Checking.

The resistance of station grounds should be checked when made.

Note: With artificial grounds this check may be made by measuring the voltage between the grounded point of the circuit, or the grounded frame of the equipment, or the grounded point of the lightning arrester, and an auxiliary metal reference rod or pipe driven into the ground, while a measured current is flowing through the ground connection and any exposed metal piping or other artificial ground not less than 20 feet distant.

If the station ground is to water piping, the check may be made with current flowing through the water piping and some independent piping system or artificial ground not less than 20 feet distant.

The auxiliary rod or pipe should be at least 10 feet from any artificial ground or piping systems through which the measured current is made to flow.

All ground connections shall be inspected periodically. Ground connections on distribution circuits should, when installed, be tested for resistance unless multiple grounding is used.

97. SEPARATE GROUNDING CONDUCTORS AND GROUNDS.

A. Grounding Conductors.

Grounding conductors from equipment and circuits of each of the following classes, if required by these rules, shall be run separately to the ground or to a sufficiently heavy grounding bus or system ground cable which is well connected to ground at more than one place, except as provided in paragraph C and in rule 285, C.

97. A. Grounding **Conductors—Continued.**

1. Lightning arresters.
2. Secondaries connected to low-voltage lighting or power circuits, except that if a secondary distribution system has multiple grounds, utilization equipment and wire enclosures may use the same grounding conductor.
3. Secondaries of current and potential instrument transformers having primary voltages of more than 750 volts, and cases of instruments on these secondaries.
4. Frames of direct-current railway equipment and of equipment operating in excess of 750 volts.
5. Frames of utilization equipment or wire raceways other than covered by item 4, except as provided in item 2.
6. Lightning rods.

B. Electrodes.

Where individual artificial grounds are used, separate grounding electrodes as well as separate grounding conductors shall be used. This does not prohibit the bonding together of these separate electrodes near the ground level.

C. Interconnection of Primary Arrester and Secondary Neutral.

1. SOLID INTERCONNECTION.

The grounding conductor of a lightning arrester protecting a transformer which supplies a secondary distribution system may be interconnected with the grounded conductor of such secondary distribution system, provided that in addition to the direct grounding connection at the arrester either:

(a) The secondary has elsewhere a grounding connection to a continuous metallic underground water piping system (except that in urban water-pipe areas where there are four water-pipe grounds

97. C. 1. Solid Interconnection—Continued.

in each mile of secondary and not less than four on any individual secondary, the direct grounding connection at the arrester may be omitted); or

(b) The secondary neutral (which may or may not be common with the primary neutral) has at least four ground connections in each mile of line in addition to a ground connection at each individual service, or

(c) Permission is obtained from the administrative authority for any other condition.

2. INTERCONNECTION THROUGH SPARK GAP.

Where the secondary is not grounded as in item 1, interconnection, if made, shall be through a spark gap having a 60-cycle breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 15 kilovolts, and there shall be at least one other ground on the grounded conductor of the secondary that is at least 20 feet distant from the lightning-arrester grounding electrode.

PART 1. RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRICAL SUPPLY STATIONS AND EQUIPMENT

CONTENTS

Page

Sec. 10. Protective arrangements of stations and substations 33
100. Scope of the rules 33
101. Application of the rules and exemptions 33
102. General requirements 34
103. Illumination 35
104. Floors, floor openings, passageways, stairs 37
105. Exits 38
106. Fire-fighting appliances 38
107. Oil-filled apparatus 39
Sec. 11. Protective arrangements of equipment 41
110. General requirement 41
111. Inspections 41
112. Guarding shaft ends, pulleys, and belts, and suddenly moving parts 42
113. Protective grounding 42
114. Guarding live parts 43
115. Working space about electric equipment 48
116. Equipment for work on live parts 49
117. Hazardous locations 50
118. Shielding of equipment from deteriorating agencies 50
119. Identification 50
Sec. 12. Rotating equipment 51
120. Speed-control and stopping devices 51
121. Guards for live parts 53
122. Grounding machine frames 53
123. Terminal bases and bushings 54
124. Deteriorating agencies 55
125. Motors 55
Sec. 13. Storage batteries 56
130. General 56
131. Isolation 57
132. Ventilation 57
133. Insulation 57
134. Racks and trays 58
135. Floors 58

Sec. 13. Storage batteries—Continued. Page
136. Wiring in battery rooms 58
137. Guarding live parts in battery rooms 58
138. Illumination for battery rooms enclosing batteries of the nonsealed type 59
Sec. 14. Transformers, induction regulators, rheostats, ground detectors, and similar equipment 59
140. Current-transformer secondary circuits 59
141. Grounding secondary circuits of instrument transformers 60
142. Grounding transformer cases 60
143. Location and arrangement of power transformers 60
144. Resistance devices 62
145. Ground detectors 62
Sec. 15. Conductors 62
150. Electrical protection 62
151. Precaution against mechanical and thermal damage 63
152. Isolation 64
153. Guarding conductors 64
154. Guarding in hazardous locations 65
155. Taping ends and joints 65
156. Wiring for illumination 65
Sec. 16. Fuses, circuit-breakers, switches, and controllers 65
160. Accessible and indicating 65
161. Oil switches 66
162. Where switches are required 66
163. Switches or other grounding devices 67
164. Capacity of switches and disconnectors 67
165. Where fuses or automatic circuit-breakers are required 68
166. Disconnection of fuses before handling 69
167. Arcing or suddenly moving parts 69
168. Grounding non-current-carrying metal parts 70
169. Guarding live parts of switches, fuses, and automatic circuit-breakers 70
Sec. 17. Switchboards 70
170. Location and accessibility 70
171. Material and illumination 71
172. Necessary equipment 71
173. Arrangement and identification 71
174. Spacings and barriers against short-circuit 72
175. Switchboard grounding 72
176. Guarding live parts on switchboards 73
177. Instrument cases 73
Sec. 18. Lightning arresters 73
180. Location 73
181. Provisions for disconnecting 74
182. Connecting wires 74
183. Grounding frames and cases of lightning arresters 75
184. Guarding live and arcing parts 75

SEC. 10. PROTECTIVE ARRANGEMENTS OF STATIONS AND SUBSTATIONS

100. Scope of the Rules.

The following rules apply to the electric supply equipment of indoor and outdoor stations and substations. Provided the equipment is in separate rooms or enclosures, under control of properly qualified persons and accessible only to such persons, they also apply to similar equipment, including generators, motors, storage batteries, transformers, lightning arresters, etc., if installed in factories, mercantile establishments, vehicles, or elsewhere.

Similar equipment under control of properly qualified persons, and accessible only to such persons, is exempted under the following conditions:

1. If the voltage does not exceed 150 volts to ground.
2. If the voltage is not more than 550 volts between conductors, and the power utilized does not exceed 3,200 watts.

101. Application of the Rules and Exemptions.

A. Application and Waiving of Rules.

The rules are intended to apply to all installations, except as modified or waived by the proper administrative authority or its authorized agents. They are intended to be so modified or waived in particular cases wherever any rules are shown for any reason to be impracticable such as by involving expense not justified by the protection secured; provided equivalent or safer construction is secured in other ways, including special working methods.

Other methods of construction and installation than those specified in the rules may also be made as experiments to obtain information, if done where supervision can be given by the proper administrative authority.

101. Application of the Rules and Exemptions—Continued.

B. Intent of Rules.

The intent of these rules which constitute a minimum standard will be realized—

1. By applying the rules in full to all new installations, reconstructions, and extensions.
2. By altering existing installations as needed in a manner approved by administrative authority.
3. The time allowed for bringing existing installations into compliance with the rules will be determined by the administrative authority.

C. Waiver for Temporary Installation.

It will sometimes be necessary to modify or waive certain of the rules in cases of temporary installations or installations which are shortly to be dismantled or reconstructed.

D. Waiver in Emergencies.

In cases of emergency, or pending decision of the administrator, the person responsible for the installation may decide as to modifications or waiver of any rule for a specified length of time, subject to review by proper authority.

102. GENERAL REQUIREMENTS.

A. Enclosure of Rooms and Spaces.

Rooms and spaces shall be so arranged with fences, screens, partitions, or walls as to prevent entrance of unauthorized persons or interference by them with equipment inside, and entrances not under observation of an authorized attendant shall be kept locked. Signs prohibiting entrance to unauthorized persons shall be displayed at entrances.

B. Rooms and Spaces.

All rooms or spaces in which electric supply equipment is installed shall comply with the following requirements:

102. B. Rooms and Space—Continued.

1. FIREPROOF CONSTRUCTION.

   They shall be, as far as practicable, noncombustible.

2. STORAGE AND MANUFACTURING PROCESSES.

   They shall be used neither for the storage of material nor for manufacturing processes causing hazard to electrical operators, except those materials or processes attendant upon the production or distribution of a supply of electric energy.

3. HAZARDOUS CONDITIONS.

   3. They shall be free from combustible dust or flyings, inflammable gas, or acid fumes, in dangerous quantities. (For battery rooms, see section 13; for auxiliary equipment in hazardous locations, see rule 117.)

4. VENTILATION.

   They should be well ventilated.

5. MOISTURE AND WEATHER.

   They should be dry. In outdoor stations or stations in wet tunnels or subways, all live parts of equipment should be enclosed in weatherproof cases, unless the equipment is suitably designed to withstand the prevailing atmospheric conditions.

C. Rotating Machinery.

Rotating machinery shall be installed upon suitable supports or foundations and if necessary secured in place.

103. ILLUMINATION.

A. Under Normal Conditions.

Rooms and spaces where electric apparatus or machinery is located shall have means for artificial illumination at intensities not less than given in table 1. The means of illumination shall be maintained ready for use at all times.

TABLE 1.—*Illumination intensities* [1]

	Location	Minimum[1]
		Footcandles
1	Switchboard instruments, gages, switches, etc	1
2	Switchboards with no exposed live parts	½
3	Storage-battery room	½
4	Generating room, boiler room, pump room	1
5	Stairways and passageways where there is moving machinery, exposed live parts, hot pipes, etc. (measured at floor level)	1
6	Any traversed space (measured at floor level)	¼

[1] The values are to be measured at working surfaces, except as stated.

Note: It is not intended that this rule should require permanent lighting in switch cells and similar small spaces occupied by electric apparatus where permanent lighting is impracticable. The Code of Lighting Factories, Mills, and Other Work Places includes general standards of illumination required from the point of view of safety.

B. Emergency Source.

A separate emergency source of illumination, from an independent generator, storage battery, gas main, lanterns (the latter two should never be used in battery rooms), or other suitable source, shall be provided in every station where an attendant is located.

C. Fixtures and Pendants.

Arrangements of permanent fixtures and plug receptacles shall be such that portable cords need not be brought into dangerous proximity to live or moving apparatus. All lamps shall be arranged to be controlled, replaced, or trimmed from safely accessible places.

Pendent conductors shall not be installed where they can be readily moved so as to bring them in contact with live parts of electric supply equipment.

D. Attachment Plugs.

Portable conductors shall be attached to fixed wiring only through separable attachment plugs which will disconnect all poles by one operation. (See sec. 37 of the code, for portables and pendants.)

104. FLOORS, FLOOR OPENINGS, PASSAGEWAYS, STAIRS.

A. Floors.

Floors shall have even surfaces and afford secure footing. Projecting nails, loose boards, uneven or greasy wood floors, and slippery floors should be avoided.

Note: Otherwise slippery floors or stairs should be provided with antislip treads.

B. Passageways.

Passageways (including stairways) and working spaces shall be unobstructed, and (except such as are used solely for infrequent inspection, construction, and repair) shall, where possible, provide at least 6.5 feet of headroom. (See rule 114 for working space.)

C. Railings.

All floor openings over 18 inches deep and raised platforms over 4 feet high shall be provided with suitable railings.

Except for loading platforms, such rails are recommended where height exceeds 18 inches, especially where they are adjacent to live or moving parts or the working space on the platform is restricted.

D. Stair guards.

All stairways consisting of four or more risers shall be provided with handrails.

For very long and steep stairs occasional landings or turns are recommended.

E. Continuity.

The heads of permanent ladders shall be provided with guards such as gates or sliding pipe sections whenever the heading breaks the continuity of a railing adjacent to working space.

For very long ladders occasional landings, turns, or safety loops are recommended.

104. Floors, Floor Openings, Passageways, Stairs—Con.

F. Floor Toe Boards.

All floor openings over 6 feet deep, and the edges of all raised platforms over 6 feet high, shall, where possible, be provided with suitable toe boards.

G. Stair Toe Boards.

Toe boards shall, where practicable, be arranged at back of stairway treads where over exposed live or moving parts or over working spaces, passageways, or other stairways.

105. EXITS.

A. Clear Exits.

Each room or space and each working space about equipment shall have suitable means of exit which shall be kept clear of all obstructions.

B. Double Exits.

If the plan of the room or space and the character and arrangement of equipment are such that an accident would be liable to close or make inaccessible a single exit, as in the case of long narrow rooms, platforms, passageways, spaces behind switchboards, or wire and pipe tunnels, a second exit shall, if practicable, be provided.

106. FIRE-FIGHTING APPLIANCES.

A. Fire extinguishers.

Adequate approved fire-extinguishing appliances shall be conveniently located and conspicuously marked. Any such appliances which have not been listed by Underwriters' Laboratories, Inc. for use on live parts should be plainly and conspicuously marked with a warning to that effect.

106. Fire-Fighting Appliances—Continued.

B. Temperature Conditions.

Fire extinguishers shall not be installed in locations subject to conditions of high or low temperature which will reduce their effectiveness.

Note: Carbon-tetrachloride extinguishers are not adversely affected by temperatures between 60° C (140° F.) and minus 40° C. (−40° F).

107. OIL-FILLED APPARATUS.

For the purposes of these rules oil-filled apparatus is divided into three classes each of which requires different treatment: (1) Oil switches and circuit-breakers, (2) transformers, induction regulators, etc., and (3) lightning arresters. The necessary safety precautions depend largely on whether they are located in buildings or outdoors.

A. Oil Switches or Circuit-Breakers.

Oil switches or circuit-breakers and their transformers, regulators, reactors, or other associated equipment should be separated from other apparatus by adequate fire-resistant barriers, or otherwise adequately isolated.

Where switches or switch compartments are constructed to prevent an appreciable amount of oil being thrown outside of the compartment, exterior drainage or storage systems are not necessary.

If located outdoors, they should be adequately isolated.

If located near building walls, these should be of fire-resistive construction and should have doors or windows so located and arranged that buring oil is not liable to pass through them to inflammable material or apparatus.

107. A. Oil Switches or Circuit-Breakers—Continued.

Note: It should be recognized that oil-switch or circuit-breaker failures may depend upon the size and rupturing capacity of the switch or circuit-breaker and the short-circuit duty that may be required of it. The short-circuit current depends on the generating capacity supplying the system on which the switch or circuit-breaker is used as modified by the current-limiting characteristics of the system or by special apparatus installed for that purpose. By "generating capacity" is meant all of the apparatus contributing to the short-circuit current.

B. Transformers, Induction Regulators, Etc., Containing a Liquid That Will Burn.

If transformers, induction regulators, etc., are in buildings, floors and floor drains should be so arranged that oil will quickly collect in a suitable drainage or storage system provided for the purpose either inside or outside of the building as may be advisable. If the apparatus contains large quantities of oil, each unit or group should preferably be placed in a separate fireproof compartment suitably ventilated.

If located outdoors, they should be adequately isolated. Provision should be made for quickly draining away to a safe distance any oil that may be spilled. This may be done by ditches and drains or the oil may be absorbed and danger of spreading removed by paving the yard around the transformers or other devices with cinders or other absorbent material to a depth of several inches.

If located in buildings, transformer tanks containing large quantities of oil shall, where practicable, be so arranged that approved fire-quenching material may be introduced above the oil inside the tank or in the surrounding compartment, except where tanks are completely filled with oil or where the space above the oil is filled with an inert gas.

C. Transformers, Induction Regulators, Etc., Containing a Liquid That Will Not Burn.

If in buildings, transformers, induction regulators, etc., filled with a liquid that will not burn should comply with section 14, rule 143.

107. Oil-Filled Apparatus—Continued.

D. Lightning Arresters.

If located in buildings, lightning arresters containing oil should be separated from other equipment by fire walls adequate to completely isolate them in case of fire.

If located outdoors, they should be adequately isolated. Provision for quickly draining away oil should be made as indicated for transformers in B above.

SEC. 11. PROTECTIVE ARRANGEMENTS OF EQUIPMENT

110. GENERAL REQUIREMENT.

All electric supply equipment shall be of such construction and so installed and maintained as to reduce the life hazard as far as practicable.

111. INSPECTIONS.

A. Regular Equipment.

Electric supply equipment shall comply with these safety rules when placed in service, and shall thereafter be periodically cleaned and inspected. Defective equipment shall be put in good order or permanently disconnected. Defective wiring, when hazardous, shall be repaired or removed.

B. Idle Equipment.

Infrequently used equipment or wiring maintained for future service should be thoroughly inspected before use to determine its fitness for service.

C. Emergency Equipment.

Equipment or wiring maintained for emergency service should be periodically inspected and, where necessary, tested to determine its fitness for service.

D. New Equipment.

New equipment should be thoroughly inspected before being put in service.

112. GUARDING SHAFT ENDS, PULLEYS, AND BELTS, AND SUDDENLY MOVING PARTS.

A. Transmission Machinery.

This code is supplemented by the Safety Code for Mechanical Power Transmission Apparatus ASA B15, which specifies methods for safeguarding pulleys, belts, and other equipment used in the mechanical transmission of power.

B. Suddenly Moving Parts.

Parts of equipment which move suddenly in such a way that persons in the vicinity are liable to be injured by being struck, such as handles and levers of circuit-breakers, shall be guarded or isolated.

113. PROTECTIVE GROUNDING.

A. Grounding Method.

All grounding which is intended to be a permanent and effective protective measure, such as lightning-arrester grounding, grounding of circuits, equipment, or wire raceways, shall be made in accordance with the methods specified in section 9, methods of protective grounding.

B. Protective Grounding or Isolation of Non-Current-Carrying Metal Parts.

All electric supply equipment, if operating at more than 150 volts to ground, or if in hazardous or damp locations, regardless of voltage, shall have the exposed non-current-carrying parts, such as frames of generators and switchboards, cases of transformers, lightning arresters and switches, and operating levers, permanently grounded or isolated.

It is recommended that exposed non-current-carrying parts of electric apparatus operating at 150 volts or less to ground be permanently grounded.

It is recommended that all metallic guards (including rails, screens, etc.) about electric supply equipment should be permanently grounded.

113. B. Protective Grounding or Isolation of Non-Current-Carrying Metal Parts—Continued.

Except in hazardous or damp locations, exposed non-current-carrying parts of equipment operating at more than 150 volts to ground may be left ungrounded and either isolated, or guarded, or provided with insulating mats as required for live parts at the same voltage. Such isolation, guarding, or mats should be so arranged that persons cannot inadvertently touch these parts while also touching a grounded surface.

C. Grounding Equipment During Repairs.

Electric equipment or conductors normally operating at more than 750 volts between conductors on or about which work is occasionally done while separated from a source of electric energy by switches or disconnectors only, shall be provided with some means, such as switches, connectors, or readily accessible ground conductor for grounding them. (See operating rules 423 and 424 of the code.)

114. GUARDING LIVE PARTS.

A. Where Required.

1. Guards shall be provided for all parts exceeding 300 volts to ground unless the boundary of the guard zone around the part has a vertical clearance of more than 7 feet 6 inches for voltages up to 7,500, and 8 feet 6 inches for voltages of more than 7,500, above any permanent supporting surface for workmen, or a horizontal clearance of more than 3 feet from the nearest edge of any such surface, or both. This includes parts exposed through windows, wall openings, etc.

   Exception: Guards need not be provided where it is necessary to permit routine inspection of rotating equipment as required under operating conditions.

114. A. Where Required—Continued.

Note: The rule applies to the electric parts energized or considered available for service in temporary or partially completed installations, as well as to permanent installations.

Definitions: The guard zone means the space of minimum clearance from guards to electric parts where guards may be installed by workmen without definite engineering design. The radius of this zone varies with the voltage as specified in column 4 of table 2. See rule 422 C of the code, for working clearances about live parts.

"Permanent supporting surface for workmen" includes floors, platforms, or structures used regularly and frequently by workmen for inspections and maintenance near live adjacent parts; runways, ladders, stairways, etc.

2. Parts over or near frequently traveled passageways through which material may be carried, or in or near spaces such as corridors, storerooms, boiler rooms, etc., used for nonelectrical work, should, where practicable, be guarded or given clearances in excess of those specified such as may be necessary to secure reasonable safety. The guards should be substantial; should, where practicable, completely shield or enclose without openings the parts; and when in spaces used for nonelectrical work should be removable only by means of tools or keys.
3. Parts of indeterminate potential, such as telephone wires exposed to induction from high-tension lines, ungrounded neutral connections, ungrounded frames, ungrounded parts of lightning arresters, ungrounded instrument cases connected directly to the high-voltage circuit, etc., shall be classified and, where practicable, guarded on the basis of the maximum voltage which may be present.

114. Guarding Live Parts—Continued.

B. Strength of Guards.

Guards shall be sufficiently strong and shall be supported rigidly and securely enough to prevent them from being displaced or dangerously deflected by a man slipping or falling against them.

TABLE 2.—*Minimum clearances from live parts*

1	2		3		4
Voltage between phases	Minimum vertical clearance of unguarded parts		Minimum horizontal clearance of unguarded parts		Minimum clearance from guards to parts. Radius of guard zone
	Feet	*Inches*	*Feet*	*Inches*	*Inches*
600	7	8	3	2	2
2,300	7	9	3	3	3
6,600	7	10	3	4	4
11,000	9	0	3	6	6
22,000	9	3	3	9	9
33,000	9	6	4	0	12
44,000	9	10	4	4	16
66,000	10	5	4	11	23
88,000	11	0	5	6	30
110,000	11	7	6	1	37
132,000	12	2	6	8	44

NOTE.—Interpolate for intermediate values.

The clearances in column 4 of this table are not a requirement for definite engineering design of either apparatus or guards, but are solely for the guidance of workmen installing guards, without such design.

For example, the minimum clearances in the table above are not intended to refer to the clearances between live parts and the walls of the cells, compartments, or similar enclosing structures. They do not apply to the clearances between bus bars and supporting structures, nor to clearances between the blade of a disconnecting switch and its base.

For the relation of the above clearance tables to the manufacture of electric apparatus, see discussion of rule 114, A.

C. Types of Guards.

1. LOCATION OR ISOLATION.

Parts having clearances equal to or greater than specified in A above are guarded by location. Parts are guarded by isolation when all entrances

114. C. Types of Guards—Continued.

to enclosed spaces, runways, ladders, etc., are kept locked or warning signs posted at all entrances, in which case no other permanent guards need be supplied.

2. GROUNDED METAL CABLE SHEATHS.

These are suitable guards except where exposed to mechanical injury. Where so exposed metal conduit or other suitable guards should be provided.

3. RAILINGS.

Railings are not substitutes for complete guards, and if used shall be located at a horizontal distance of at least 3 feet (and preferably not more than 4 feet) from the nearest point of guard zone, which is less than 7½ feet above the floor.

4. SHIELDS OR ENCLOSURES.

Guards inside of the guard zone or less than 4 inches outside, shall completely enclose the parts from contact up to the heights listed in column 2 of table 2. They shall not be closer to the live parts than listed in column 4 of table 2, except when suitable insulating material is used with circuits of less than 7,500 volts. (See note under table 2.) If more than 4 inches outside of the guard zone, the guards need not extend more than 7½ feet above the floor. Covers or guards, which must at any time be removed while the parts they guard are alive, should be arranged so that they can not readily be brought in contact with live parts.

5. INSULATING COVERING ON CONDUCTORS OR PARTS.

The insulating covering on parts exceeding 750 volts to ground shall not be considered a protection. For parts less than 750 volts, positive barriers, enclosures, or similar arrangements are preferable, but in dry places where not exposed to mechanical injury, varnished-cloth tape, or

114. C. 5. Insulating Covering on Conductors or Parts—Continued.

other insulation suitable for the voltage involved may be used as a guard. The taping over connections shall be of a type and thickness suitable for the voltage involved. Friction tape is not acceptable as the sole protection.

Exception: On circuits not exceeding 7,500 volts between phases, when other guarding is impracticable, insulation suitable for the voltage involved may be used back of switchboards or in equivalent sheltered locations. Insulating mats or platforms shall be provided so that an operator can not readily touch the insulating covering without standing on the mats.

6. MATS.

Suitable insulating mats placed so that a person cannot inadvertently come in contact with the live parts without standing on the mat may be used in the following cases:

(a) Parts less than 750 volts to ground exposed at switchboards, switches, or on rotating machinery.

(b) Disconnect switches less than 7,500 volts between phases mounted on back of switchboards or in similar sheltered locations when barriers are placed between each blade so as to extend beyond the disconnected parts in any position. Other means of guarding may be used where convenient.

(c) Ungrounded frames of existing high-voltage series generators.

(d) As provided for in paragraphs C, 5, and C, 8, of this rule, mats should be of rubber or other suitable insulating material. In dry locations they may be of wood fastened with wood pins, cork matting, or heavy

114. C. 6. Mats—Continued.

(¼-inch) linoleum laid without joints and without metal fastenings. A "nonslip" surface should be maintained, and the mats should be laid and maintained so as to reduce the tripping hazard to a minimum.

Note: Beveled edges will help in many cases.

7. PARTS BELOW SUPPORTING SURFACES FOR PERSONS.

The supporting surfaces above live parts shall be without openings. Toe boards at least 6 inches high shall be provided at all edges.

8. SPECIAL RULES FOR PLUG-TYPE SWITCHBOARDS.

A mat is a suitable guard when placed so that the operator must stand on it when operating the plugs. Suitable guards on handles of all plugs shall be provided.

D. Parts of Less Than 300 Volts to Ground.

It is recommended that live parts of more than 150 volts to ground be enclosed or guarded when in exposed locations.

115. WORKING SPACE ABOUT ELECTRIC EQUIPMENT.

A. Where Required.

Adequate and readily accessible working space with secure footing shall be maintained about all electric parts or equipment which require adjustment or examination if exposed *while in service.*

B. Width of Working Space.

The horizontal clearance from the farthest edge of the working space to the nearest live part of more than 300 volts to ground, exposed after removing guards, shall be not less than 3 feet plus the guard zone radius as given in column 4 of table 2. (If the live parts are on only one side, column 3 of table 2

115. B. Width of Working Space—Continued.

gives the minimum permissible value for the total width of the free space.) See also rule 104, B, for head room.

C. Elevated Parts.

Clearance about normally elevated or isolated parts requiring occasional adjustment should be provided so the men need not come within the danger zone (see rule 422, C, of the code), around adjacent energized parts, unless guarded in accordance with rules 114 to 116, inclusive.

116. EQUIPMENT FOR WORK ON LIVE PARTS.

A. 7,500 Volts or Less Between Phases.

When it is necessary for men to bring their bodies or any material or tools handled into the danger zone (see rule 422, B, of the code), suitable protective devices, such as rubber gloves, rubber sleeves (if necessary), insulating tools, portable rubber mats or insulating stools, rubber blankets, insulated fuse pullers, testing and grounding devices, switchsticks, etc., should be provided, periodically examined, and kept in safe condition. If the voltage exceeds the limit of 5,000 volts set for standard rubber gloves, special gloves should be furnished if the work is conducted so that their use is necessary.

B. More Than 7,500 Volts.

Suitable protective devices, such as testing and grounding devices, switch sticks, fuse pullers, special insulated tools, etc., should be provided, periodically inspected, and kept in safe condition. Such devices shall provide an ample margin of safety for the voltage involved and should be constructed so that the workman's body can remain outside of the danger zone. (See rule 422, C, of the code.)

117. HAZARDOUS LOCATIONS.

A. Enclosure of Arcing and Heating Parts.

In locations where inflammable gas or inflammable flyings normally exist in dangerous quantities, all parts where sparking, arcing, or dangerous heating is liable to occur, shall be enclosed so as to reduce the hazards as far as practicable.

This inclosure shall be by one of the following methods:

1. By placing in separate compartments or rooms.
2. By using nonabsorptive, noncombustible casings of the solidly enclosed type when inflammable dust or flyings are present.
3. By using nonabsorptive, noncombustible, explosion-proof casings when inflammable gas exists in dangerous quantities.

B. Grounding.

The metal frames and other exposed non-current-carrying metal parts of equipment in these locations shall be permanently grounded as specified in section 9.

118. SHIELDING OF EQUIPMENT FROM DETERIORATING AGENCIES.

Suitable shields or enclosures shall be provided to protect exposed current-carrying parts, insulation of leads or electric devices or equipment where susceptible to injury by being installed directly under rotating equipment or in other locations where dripping oil, excessive moisture, steam, vapors, or similar agents exist. (For battery rooms see rule 136.)

119. IDENTIFICATION.

A. Equipment in General.

Electric supply equipment shall be suitably identified when necessary for safety. The identification may be by position, color, number, name plate, label, design, or other means, but the method of identification chosen shall be uniform throughout any one system. (See rule 164, A, for switches.)

119. A. Equipment in General—Continued.

The voltage and intended use shall be shown if important.

Identification marks should not, if avoidable, be placed on removable covers or casings, such as instrument covers and disconnector compartment doors, where the interchanging of these removable parts might lead to accident.

B. Generators and Motors.

Generators and motors shall each be provided with a name plate giving the maker's name, the rating, normal full-load speed, and the voltage.

SEC. 12. ROTATING EQUIPMENT

(This includes generators, motors, motor-generators, and converters)

120. SPEED-CONTROL AND STOPPING DEVICES.

A. Speed limits for prime movers.

Prime movers driving generating equipment shall be provided with automatic speed-limiting devices, where harmful overspeed can otherwise occur, in addition to their governors, if necessary, as with some types of steam turbines.

B. Stops for Rotating Equipment.

Stopping devices, such as switches or valves which can be operated from locations convenient to machine operators, shall be provided for prime movers or motors driving generating equipment.

Devices which operate in such a way that the development of defects or their becoming inoperative will stop the units protected, should be used where practicable.

Controls to be used in emergency for machinery and electric equipment should be so located as to permit operation with a minimum of danger during such emergency. (See rule 165 for fuses and circuit-breakers.)

120. Speed-Control and Stopping Devices—Continued.

C. Speed Limit for Motors.

Machines of the following types shall be provided with speed-limiting devices unless their inherent characteristics or the load and the mechanical connection thereto are such as to safely limit the speed, or unless the machine is always under the manual control of a qualified operator:

1. Separately excited direct-current motors.
2. Series motors.
3. Motor-generators and converters which can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load.

Note: The required limitation of speed may be obtained by the use of a relay, centrifugal switch, or other similar device which will cut off the supply of energy when excessive speed is attained.

D. Low-Voltage or Under-Voltage Protection.

All motors so employed or arranged that an unexpected starting of the motor is a hazard, except those with an emergency use, and where the opening of the circuit may cause a special hazard, such as exciter or condenser-pump motors, shall be equipped with low-voltage protection which instantaneously or after a predetermined delay will automatically cause and maintain the interruption of the motor circuit when the voltage falls below an operating value.

E. Adjustable-Speed Motors.

Adjustable-speed motors, if controlled by means of field regulation, shall be so equipped and connected that the field cannot be weakened sufficiently to permit a dangerous speed.

F. Protection of Control Circuits.

Where speed-limiting or stopping devices are electrically operated, the control circuits by which such devices are actuated shall be in conduit or

120. F. Protection of Control Circuits—Continued.

otherwise suitably protected from mechanical injury, in accordance with rule 151.

121. GUARDS FOR LIVE PARTS.

A. Guards on Rotating Equipment.

Guards complying with rule 114 shall be provided.

B. Access to Live Parts.

Where necessary, steps and handrails shall be installed on or about large machines to afford ready access to live parts which must be examined or adjusted during operation.

C. Frame Switches.

Where switches are installed on the frames of generating equipment for the purpose of reducing inductive voltage in generator and converter field coils they shall be suitably constructed or guarded to prevent passers-by from inadvertently coming in contact with the live parts, to protect persons handling them, and to prevent their being accidentally opened or closed.

D. Arcing Shields.

Suitable shields or barriers other than rails shall be provided where practicable to prevent arcing on large commutators or any other parts of moving apparatus from injuring persons in the vicinity, as in the case of narrow working spaces located immediately above or beside such equipment.

Exception: Twenty-five-cycle apparatus of less than 150 volts to ground is exempted.

It is recommended that where suitable shields have not been installed, goggles should be available.

122. GROUNDING MACHINE FRAMES.

A. Grounding Machine Frames.

All frames of rotating electric equipment shall be permanently grounded except as permitted below and in rule 113.

122. Grounding Machine Frames—Continued.

B. Coupled Machines.

Where two or more machines, either of which operates at more than 150 volts to ground, are mechanically coupled together and the operator can touch the frames of more than one at a time, the frames of all such shall be permanently grounded or bonded together electrically.

Exception: This rule may be waived with high-voltage series generator sets in existing installations where for operating reasons the generators must have their frames insulated from the ground and the motor frame is grounded, and where it is impracticable to place insulating barriers between the grounded and ungrounded frames.

C. Auxiliaries.

Exciters and auxiliary circuits electrically connected to generators or other machines of more than 750 volts to ground (with frames ungrounded) shall be installed, protected, and identified as machines and circuits of the same voltage as that of the machine for which they are auxiliaries.

123. TERMINAL BASES AND BUSHINGS.

A. Terminal Bases.

Terminal bases, if used on motors or generators, should preferably be of suitable fire-resistant and moisture-resistant insulating material such as slate, marble, or porcelain. It is recommended that unguarded terminals be protected by a cover of insulating material or grounded metal.

B. Bushings.

Bushings, where used for wires coming through the frames of motors or generators, should preferably be of porcelain, suitable composition material, or of hardwood properly filled; except that soft rubber may be used if not exposed to oils, grease, or other deleterious substances in such quantities as to cause their rapid destruction.

124. DETERIORATING AGENCIES.

A. Protection Required.

Suitable shields or enclosures shall be provided to protect exposed current-carrying parts, insulation of leads, balance coils, or other electric devices belonging to motors and generating equipment where installed directly under equipment or in other locations where dripping oil, excessive moisture, steam, vapors, or similar injurious agents exist.

B. Grounding.

The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be permanently grounded.

125. MOTORS.

A. Control.

If the starting is caused automatically (not manually) as, for example, by a float switch, or if the starting device or control switch is not located close to the motor and all parts of the machinery operated, the starting arrangement shall be designed so that it can positively be kept open by means of locks or equivalent devices.

B. Motors in Hazardous Locations.

Motors with their auxiliary equipment, at which sparking or arcing or high temperature is liable to occur, if in rooms normally containing explosives, inflammable gas, or inflammable flyings, shall be so installed as to reduce the hazard by enclosure in an adequately ventilated separate compartment, by solidly enclosed or explosion-proof type of equipment, or when to be protected against flyings only, by partitioning off a space or by a suitable boxing.

C. Motors Exposed to Dust.

Motors should be protected from dust. Enclosed-type motors are recommended in dusty places, being preferable to boxing.

125. Motors—Continued.

D. Motors on Wooden Floors.

Where practicable, motors permanently located on wooden floors should be provided with suitable drip pans.

SEC. 13. STORAGE BATTERIES

130. GENERAL.

The provisions of this section are intended to apply to all stationary installations of storage batteries using acid or alkali as electrolyte, consisting of cells connected in series, with a nominal voltage in excess of 50 volts, and connected for service where so installed. (For exception, see rule 132, B.)

Nominal battery voltage shall be calculated on the basis of 2.0 volts per cell for lead-acid type and 1.2 volts per cell for alkali type. "End" or "Emergency" cells, held in reserve for connection into circuit only to maintain voltage during discharge, are not included in calculating nominal battery voltage.

Two types of cell construction are recognized in this section, viz:

1. The sealed type in which the only passage for the escape of gases from the interior of the cell is provided by a vent of effective spray-trap design adapted to trap and return to the cell, particles of liquid entrained in the escaping gases.
2. The nonsealed type, in which gases escaping from the cell may carry entrained particles of liquid into the surrounding atmosphere.

Caution: Smoking, or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided as they may ignite the gas if discharged close to its source, as at the vent of a sealed-type cell during

130. 2. Caution—Continued.

overcharging. The electrolyte of storage batteries, and spray containing electrolyte, are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothes should be avoided.

131. ISOLATION.

Storage batteries should be so located as to be not accessible to other than properly qualilfied persons.

132. VENTILATION.

A. Diffusion of Gases.

Provision shall be made for sufficient diffusion of the gases from the battery to prevent the accumulation of an explosive mixture.

B. Nonsealed Type.

Batteries of the nonsealed type shall be located in separate rooms or enclosures so arranged as to prevent the escape into other rooms of objectionable quantities of electrolyte spray. This applies also to batteries of the nonsealed type not exceeding 50 volts nominal voltage if the capacity at the 8-hour discharge rate exceeds 5 kw-hrs.

133. INSULATION.

Cells of the nonsealed type shall be supported by suitable insulators such as glass, glazed porcelain, or oil type, or may be grouped and supported on glass or other suitable insulating trays.

Cells of the alkali type in jars of conducting material shall be supported singly, or in groups assembled in nonconducting trays, on porcelain or other suitable insulators.

Cells of the sealed type in containers of insulating material require no additional insulation except as follows: Cells in rubber or composition containers if the total voltage exceeds 150 volts, or cells in glass jars if the total voltage exceeds 250 volts, should preferably be sectionalized into groups not exceeding these voltages, and such

133. Insulation—Continued.

groups shall be mounted on trays or racks supported by suitable insulators such as glass, glazed porcelain, or oil type.

134. RACKS AND TRAYS.

A. Racks.

Racks, as required in this section, refer to frames designed to support cells or trays. They shall be substantial and made of:

1. Wood, so treated as to be resistant to deteriorating action by the electrolyte; or
2. Metal, so treated as to be resistant to deteriorating action by electrolyte and provided with nonconducting members directing supporting the cells; or with suitable insulating material on conducting members; or
3. Other similar suitable construction.

B. Trays.

Trays refer to frames such as crates or shallow boxes usually of wood or other nonconducting material so constructed or treated as to be resistant to deteriorating action by the electrolyte.

135. FLOORS.

It is recommended that the floors of battery rooms in which large batteries comprised of cells in lead-lined wood tanks are installed be of acid-resistive material, or be painted with acid-resistive paint, or otherwise be protected, where acid is likely to drop and accumuate.

136. WIRING IN BATTERY ROOMS.

Wiring shall be in accordance with the requirements of the National Electrical Code (storage batteries).

137. GUARDING LIVE PARTS IN BATTERY ROOMS.

A. Guarding.

The arrangement of cells and connections shall be such that any two current-carrying parts between

137. A. Guarding—Continued.

which a voltage exceeding 150 volts exists shall be properly guarded if the parts are otherwise so exposed that persons are liable to make accidental contact with both at the same time.

B. Bare Conductors.

No bare conductor of more than 150 volts to ground shall be placed in any passageway, unless guarded or isolated by elevation.

C. Details of Guards.

Required guards shall comply with rule 114.

138. ILLUMINATION FOR BATTERY ROOMS ENCLOSING BATTERIES OF THE NONSEALED TYPE.

A. Type of Lamp.

Storage-battery rooms, in addition to daylight which is desirable when available, should be lighted only by incandescent electric lamps in keyless porcelain or composition sockets, controlled from outside the battery room if practicable.

It is recommended that portable lamps be used only in keyless sockets enclosed in holders provided with substantial guards to prevent lamp breakage and be provided with "hard-service" cord.

B. Heating Appliances.

Heating appliances with open flames or exposed incandescent resistors shall not be installed.

SEC. 14. TRANSFORMERS, INDUCTION REGULATORS, RHEOSTATS, GROUND DETECTORS, AND SIMILAR EQUIPMENT

140. CURRENT-TRANSFORMER SECONDARY CIRCUITS.

A. Short-Circuiting.

Secondary circuits of current transformers, including constant-current and instrument transformers, shall be provided with means (such as permanent connections for jumpers) for short-circuiting them which can be readily connected while the primary is ener-

140. A. Short-Circuiting—Continued.

gized and which are so arranged as to permit the removal of any instrument or other device from such circuits without opening the circuits.

B. Protection When of More Than 7,500 Volts.

Where primaries are of more than 7,500 volts, secondary circuits unless otherwise adequately protected from injury or contact of persons, shall be in permanently grounded conduit.

141. GROUNDING SECONDARY CIRCUITS OF INSTRUMENT TRANSFORMERS.

The secondary circuits of all instrument transformers shall be permanently grounded unless the circuits are installed, guarded, and plainly identified as required for the secondary circuits of transformers, in accordance with rule 150.

Note: This will sometimes require marking to distinguish such a circuit from others with which it is associated, but which are protected by ground connections.

142. GROUNDING TRANSFORMER CASES.

The metal case or exposed frame of each transformer, reactor, induction regulator, and similar equipment, which is located where dampness or inflammable gas normally exists, or which is connected to a circuit operating at more than 150 volts to ground, shall be permanently grounded.

Exception: Exception is permissible in accordance with rule 113, B, in locations free from inflammable gas, where the entire transformer is isolated or guarded as required for the highest-voltage circuit connected with the transformer, and is plainly and conspicuously identified as of that voltage.

143. LOCATION AND ARRANGEMENT OF POWER TRANSFORMERS.

If located outdoors, transformers shall be installed in accordance with paragraph A, B, or C below; if located indoors, or in sidewalk vaults communicating

143. Location and Arrangement of Power Transformers—Continued.

with the interior of the building, they shall be installed in accordance with paragraph D, E, or F below.

A. On Poles.

Transformers may be mounted on a pole or on a pole structure, in compliance with the rules of part 2.

B. On Walls.

If permitted by local authority, a transformer may be mounted on the exterior wall of a building, in compliance with the rules of part 2.

C. Enclosed.

A transformer may be mounted in an outdoor enclosure such that unauthorized persons cannot readily come in contact with any part of the casing or wiring.

D. Indoors, Combustible Liquid.

A transformer immersed in a liquid that will burn, and located in a station, should be provided with sills to confine any escaping liquid, or with suitable arrangements for draining. If located in a building used for other than station purposes, and the amount of such liquid is considerable, the transformer should be placed in a suitable transformer vault which is ventilated. Such a vault shall be accessible to authorized persons only.

E. Indoors, Incombustible Liquid.

A transformer rated in excess of 25 kva and immersed in a liquid that will not burn shall be furnished with a pressure-relief vent. If installed inside a building used for other than station purposes and not well-ventilated, (1) the transformer shall be furnished with a means for absorbing any gases generated by arcing inside the case, or (2) the pressure-relief vent shall be connected to a chimney or flue which will carry such gases outside the building.

143. Location and Arrangement of Power Transformers—Continued.

F. Indoors, Other Types.

Other types of transformers, such as air-cooled transformers, or small transformers (25 kva or less) immersed in a liquid that will not burn, may be installed in stations or, if properly enclosed or guarded, in buildings used for other than station purposes.

144. RESISTANCE DEVICES.

Rheostats shall be not less than 1 foot from combustible material or separated therefrom by a slab or panel of noncombustible, nonabsorptive material of suitable thickness, not less than one-half inch, somewhat larger than the rheostat, and secured in place by bolts independently of the rheostat supports.

Rheostats or resistance devices shall not be placed where spattering molten metal due to high temperature in the rheostat may fall upon inflammable material or spaces frequently occupied by persons.

Rheostats or resistance devices exposed to excessive dust or flyings should preferably be installed in suitable cabinets or equipped with dustproof side and face plates. (For installation in hazardous locations, see rule 117.)

145. GROUND DETECTORS.

Every station supplying circuits which are not permanently grounded in accordance with section 9 shall be provided with one or more reliable means of ground detection which can be applied to determine the existence of a ground on any such circuit extending outside the station.

SEC. 15. CONDUCTORS

150. ELECTRICAL PROTECTION.

A. Overcurrent Protection Required.

Conductors shall be suitable for the location, use, and voltage. Conductors shall be protected against excessive heating by the design of the system or by

150. A. Overcurrent Protection Required—Continued.

suitable fuses or automatic circuit-breakers except as provided in rule 165.

Automatic circuit-breakers may be set so as to interrupt the circuits only on excessive short-circuits, if constant attendance is provided and protection is thus also afforded by manual operation.

B. Fuses in Grounded Conductors.

Conductors normally grounded for the protection of persons shall be arranged without fuses or automatic circuit-breakers interrupting their continuity between the source of electrical supply and the point at which the ground conductor is attached, unless the circuit-breaker opens all conductors of the circuit with one operation.

C. Circuits Exposed to Higher Voltages.

If exposed through transformer windings or outdoor circuits to higher voltages, circuits of less than 750 volts shall be isolated or grounded unless in suitable cable with grounded metal sheath, placed in grounded conduit or other suitable duct, or identified and guarded as required for conductors of the highest voltage to which they are exposed.

151. PRECAUTION AGAINST MECHANICAL AND THERMAL DAMAGE.

A. Protection Against Injury.

Where exposed to mechanical injury suitable casing, armor, or other means shall be employed to prevent injury or disturbance to conductors, their insulation, or supports.

B. Flameproofing.

Where conductors with insulating coverings are closely grouped and any one is liable to damage from near-by conductors (as sometimes on the rear of switchboards or in cableways), they shall have a substantial flameproof outer covering.

151. Precaution Against Mechanical and Thermal Damage—Continued.

C. Protection Against Contact.

Large conductors liable to be torn from their supports by the forces to which they are subjected (as by the magnetic fields produced) shall be so supported that they cannot come in contact with the surfaces along which they are run if uninsulated or with other conductors and equipment.

Note: This applies in particular to generator leads and conductors liable to large short-circuit currents.

D. Conductors Between Generators and Outside Lines.

Conductors between generators and outside lines shall be accessible and supported on approved noncombustible, nonabsorptive insulators or placed in approved cable, metal conduit, tile, or other fireproof ducts.

E. High Temperatures.

Insulated conductors exposed to excessive temperatures shall have insulation which remains effective and does not rapidly deteriorate under such conditions.

152. ISOLATION.

All conductors of more than 750 volts to ground, and ungrounded bare conductors of more than 300 volts to ground, shall be isolated by elevation or guarded in accordance with rule 114, so that no person can inadvertently come in contact with them; provided that busses and bus structures and line connections thereto may be installed in accordance with rule 115, in suitable locations specially arranged for such purposes.

153. GUARDING CONDUCTORS.

A. Metal-Sheathed Cable Outlets of More Than 750 Volts Between Conductors.

The insulation of the several conductors of multiple-conductor cable, where leaving the metal sheath at outlets, shall be thoroughly protected from mechanical injury, moisture, and electrical strains by means of a pothead or equivalent method.

153. Guarding Conductors—Continued

B. Form of Guards.

Guards shall comply with rule 114.

154. GUARDING IN HAZARDOUS LOCATIONS.

A. Conduit or Metal Sheath.

Conductors in locations where inflammable gas normally exists shall be in metal conduit or metal-sheathed cable. All fittings and outlets of such conduit and cable shall be electrically and mechanically continuous with the conduit or metal sheath, and the conduit shall be sealed to prevent entrance of gases.

Note: This rule does not apply to conductors of large cross section which obviously cannot be placed in conduit such as copper bars connecting large cells with end-cell switches.

B. Insulating supports.

Conductors in damp locations, if neither in conduit nor in waterproof metal sheaths in other suitable ducts, shall be effectively isolated and supported on a suitable type of insulator.

155. TAPING ENDS AND JOINTS.

Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating covering with other portions of the conductor.

156. WIRING FOR ILLUMINATION.

Wiring installed for the illumination of the station should be installed and protected as required for similar utilization equipment and conductors in part 3 of the code.

SEC. 16. FUSES, CIRCUIT-BREAKERS, SWITCHES, AND CONTROLLERS

160. ACCESSIBLE AND INDICATING.

A. Arrangement.

All switches, fuses, automatic circuit-breakers, starting rheostats, and other control devices shall be readily and safely accessible to authorized persons,

160. A. Arrangement—Continued.

unless remotely controlled. They shall be so arranged or marked as to identify the equipment controlled by them, and (except fuses) shall indicate whether they are open or closed.

B. Accidental Closing.

Switches shall be so installed as to minimize the danger of accidental operation, and where practicable so that gravity cannot close them; such switches as may tend to close by gravity shall be provided with a proper latch or stop block to prevent accidental closing. Where practicable, the blades of knife switches should be dead when the switches are open.

161. OIL SWITCHES.

Oil circuit-breakers and oil switches shall, wherever practicable, be isolated from other types of switches and other electric apparatus to conform to rule 107, A. Remote control of switches and circuit-breakers shall be used on circuits of more than 7,500 volts, or when they may be subject to large short-circuit values.

Note: Remote control may be of mechanical, electrical, or other type. It is not intended to prohibit the use of switches and circuit-breakers operated manually by means of levers or poles from a remote position. (See note in rule 107, A, for conditions usually applying to electrical systems.)

162. WHERE SWITCHES ARE REQUIRED.

Suitable disconnectors, switches, or circuit-breakers which may be manually operated shall be inserted in all leads to all supply equipment and all outgoing supply circuits, except as listed below.

Exception 1:

Where two or more pieces of electric supply equipment or supply lines are operated as a single unit, no switch is necessarily required between them.

Exception 2:

Switches are not required in transformer vaults except as may be deemed necessary by the engineer in charge to meet operating requirements.

162. Where Switches are Required—Continued.

Exception 3:

Switches are not required in leads to instrument transformers.

Exception 4:

Switches are not required in grounded conductors.

Note: In most cases the switch called for should be capable of opening the circuit under loads. In some cases, as between generators and transformer banks used with them, disconnectors only would be required.

163. SWITCHES OR OTHER GROUNDING DEVICES.

It is recommended that switches or other suitable means be provided, where practicable, to facilitate short-circuiting and grounding equipment or lines for which the operating rules (see rules 423 and 424 of the code) require grounding to protect workmen. (See rule 113, C.)

164. CAPACITY OF SWITCHES AND DISCONNECTORS.

A. Suitability.

Switches used otherwise than as disconnectors shall be of suitable voltage and ampere rating for the circuit on which they are installed and should preferably be marked with the current which they can safely interrupt.

Disconnectors shall be of suitable voltage and ampere rating for the circuit on which they are installed.

It is recommended that disconnectors be marked with warning against opening when carrying load. Where a group of disconnectors is contained in one room or compartment, a single conspicuous sign may be sufficient.

B. Locking.

Remotely controlled switches, oil switches, and disconnectors shall be so arranged that they can be secured in the open position or plainly tagged to prevent careless closing while work is being done on equipment controlled by them.

It is important that the control circuit be tagged or provided with a positive disconnecting means near

164. B. Locking—Continued.

the apparatus to prevent accidental operation of the mechanism.

For switches and disconnectors the accidental opening of which may cause hazard, similar arrangements are desirable for retaining them in closed position.

Locking is recommended rather than blocking wherever parts of equipment are remote from the point of control.

C. Air Break.

Unless a switch operating on a circuit between 750 and 7,500 volts makes an air break, it is recommended that there shall be installed between it and the source of energy supply a suitable air- or oil-break disconnector or equivalent device having an air or oil gap suitable for the operating voltage of the circuit.

An air-break switch or air-break disconnector shall be inserted in each conductor between electric supply equipment or lines and sources of energy of more than 7,500 volts, if the equipment or lines may have to be worked on without protective grounding while the sources may be alive. (For lightning arresters see rule 181.)

D. Alinement.

Knife switches shall maintain such alinement under service conditions that they can be closed with a single unhesitating motion.

165. WHERE FUSES OR AUTOMATIC CIRCUIT-BREAKERS ARE REQUIRED.

All circuit leads to motors, constant-potential generators, transformer primaries, and station auxiliaries, and all outgoing circuits shall be protected from excessive current by suitable fuses or automatic circuit-breakers, except as indicated below.

Fuses and automatic circuit-breakers may be omitted from the following:

165. Where Fuses or Automatic Circuit-Breakers Are Required—Continued.

1. A motor-driven generator or rotary converter not operated in parallel with other machines or batteries if the supply leads to such apparatus are already protected by fuses or automatic circuit-breakers.
2. Grounded conductors.
3. Circuits for field excitation.
4. Leads of alternating-current generators.
5. Leads connecting two or more pieces of electric supply equipment operated as a single unit.
6. Circuits supplying interconnected three-wire systems of direct-current distribution.
7. Leads of series transformers.
8. Leads of potential transformers or other circuits the opening of which may cause greater hazard to life or property through interruption of service.

166. DISCONNECTION OF FUSES BEFORE HANDLING.

Fuses in circuits of more than 150 volts to ground or more than 60 amperes shall be arranged in one of the following ways:

1. So that the fuses are necessarily disconnected from all sources of electric energy before they can be touched.
2. So that the fuses can be disconnected from all sources of electric energy by a suitable switch.
3. So that the fuses can be conveniently handled by means of insulating handles or portable tools provided for the purpose.

Exception: Circuits of less than 150 volts to ground and less than 60 amperes capacity are exempted from the provisions of this rule.

The use of insulating gloves and mats is permissible on circuits not exceeding 750 volts.

167. ARCING OR SUDDENLY MOVING PARTS.

A. Protection From Burns.

Fuses and circuit-breakers shall, as far as possible, be so designed, located, or shielded that persons will not be burned by their operation.

167. Arcing or Suddenly Moving Parts—Continued.

Protection Against Moving Parts.

Handles or levers of circuit-breakers and similar parts which may move suddenly, in such a way that persons in the vicinity are liable to be injured by being struck by them, shall be guarded or isolated.

168. GROUNDING NON-CURRENT-CARRYING METAL PARTS.

Exposed non-current-carrying metal parts of switch and fuse cases, levers, and other similar parts to which leakage is liable to occur from live parts, and thereby create a hazard, shall be permanently grounded in accordance with rule 113.

Exception: Minor parts, such as ferrules of knife switches, which are not liable to become alive, are excepted.

169. GUARDING LIVE PARTS OF SWITCHES, FUSES, AND AUTOMATIC CIRCUIT-BREAKERS.

Switches, fuses, and automatic circuit-breakers shall be isolated or guarded in accordance with rules 114 and 115.

SEC. 17. SWITCHBOARDS

170. LOCATION AND ACCESSIBILITY.

A. General Location.

Switchboards shall, where practicable, be so placed that the operator will not be endangered by any live or moving parts of machinery or equipment located near the board.

They shall be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material.

B. Spaces About Boards.

The space back of the board shall be kept clear of rubbish and shall not be used for storage.

C. Accessibility.

Switchboards shall be accessible to authorized operators from both sides when the connections are on the back (see rule 115 for working space), but may be placed against a wall when operating at not

170. C. Accessibility—Continued.

more than 750 volts between conductors with the wiring entirely on the face.

D. Arrangements.

Switchboards shall have all switches so arranged that the points of control are readily accessible to the operator. Instruments, relays, and other devices requiring reading or adjustments shall be so placed that work can be readily performed from the working space.

171. MATERIAL AND ILLUMINATION.

A. **Material.**

Switchboards shall be made of noncombustible material and be kept free from moisture.

B. **Illumination.**

Sufficient illumination shall be provided both for the front and rear of the switchboard so that the switchboard may be readily operated and instruments conveniently read.

172. NECESSARY EQUIPMENT.

Switchboards which control generating equipment or outgoing supply circuits shall (except in substations without regular attendance) be equipped with such instruments as are necessary to show operating conditions. (See rule 145 for ground detectors.)

173. ARRANGEMENT AND IDENTIFICATION.

Connections, wiring, and equipment of switchboards and panelboards shall be arranged in an orderly manner, and all switches, fuses, and circuit-breakers shall be plainly marked, labeled, or arranged so as to afford ready means for identifying circuits or equipment supplied through them, in accordance with rule 119.

174. SPACINGS AND BARRIERS AGAINST SHORT-CIRCUIT.

A. Bare Parts.

Switchboards shall have the number of bare parts at different potentials on any panel reduced to a minimum, and these parts shall be effectively separated. Protection or separation of such parts by suitable barriers is recommended where the voltage exceeds 750 between conductors.

It is recommended that such parts, including bus bars, should be so located, or provided with such insulating coverings or barriers, that parts at different potentials will not be readily short-circuited by tools or other conducting objects.

B. Fuses.

Fuses should be so located as to minimize the danger, in removing or replacing them, of short-circuiting parts at different potentials by the fuses or by the hands of the operator.

175. SWITCHBOARD GROUNDING.

A. Frames.

Switchboard frames and noncurrent-carrying parts shall be permanently grounded under the conditions and with the exceptions noted in rule 113.

Exception: Parts of switchboards, such as name plates, screws, and similar small parts which are not liable to become alive, except under very unusual circumstances, are not considered as coming under the rule and may be left ungrounded.

B. Circuits Worked on.

Where protective grounds are occasionally required on circuits for the protection of workmen, a permanent ground connection shall be provided, and also suitable means for effectively and readily connecting the parts being grounded to the ground connection, in accordance with rule 113C.

176. GUARDING LIVE PARTS ON SWITCHBOARDS.

A. Guards.

Live parts of switchboards shall be guarded in accordance with rule 114.

B. Plug-Type Switchboards.

Plug-type switchboards should, except while connections are being changed, have no current-carrying part exposed on face of boards; and, if practicable, they and their plug connectors shall be so arranged where the operating voltage exceeds 150 as to have all current-carrying parts guarded so long as they are alive, even while connections are being changed.

C. Exposed Parts of More Than 7,500 Volts.

No switchboard shall have current-carrying parts of more than 7,500 volts exposed (unguarded) unless these parts are effectively isolated by elevation, except at times when occasionally left exposed by removal of covers or entrance into enclosures, such as switch and instrument-transformer cells or compartments, which are ordinarily unoccupied by persons. For such parts, if exposed while alive for any purpose (including busses and disconnectors in compartments), working space shall be provided complying with the requirements under rule 115.

177. INSTRUMENT CASES.

If mounted on switchboards, metal cases of instruments (unless isolated by elevation) operating at more than 750 volts between conductors shall be grounded or enclosed in suitable covers which are either of grounded metal or of insulating material.

SEC. 18. LIGHTNING ARRESTERS

180. LOCATION.

A. Where Required.

Suitable precautions should be taken to protect station equipment against excessive lightning which might enter from associated overhead lines.

180. A. Where Required—Continued.

Exception: Precautions need not be taken in locations where thunderstorms are infrequent at all seasons of the year.

Note: Protection against lightning can be obtained in several ways, such as ground wires, graded insulation, arresters, capacitors, protector tubes, spark gaps, etc.

B. Indoors.

Lightning arresters with auxiliaries, if installed inside of buildings shall be located well away from all other equipment, passageways, and combustible parts of buildings. If of a type containing oil, they should be installed in accordance with rule 107.

181. PROVISIONS FOR DISCONNECTING.

A. Air-Break Disconnectors.

Lightning arresters on circuits of more than 7,500 volts shall be so arranged, isolated, and equipped that they may readily be disconnected from conductors to which they are connected by means of disconnects or clamping devices operable from a safe working distance.

These disconnecting devices should be installed at a sufficient distance from all parts of the arrester equipment to make it safe to perform maintenance and inspection work on any part of the arrester.

B. Working Space.

Such disconnectors, unless remotely controlled and operated, shall have the adjacent working spaces required by rule 115 for disconnectors generally.

182. CONNECTING WIRES.

Grounding wires shall be run as directly as possible and be of low impedance and ample current capacity. (See sec. 9 for methods of protective grounding.)

Kinks and coils in the wires between the arresters and the outdoor lines shall be avoided as far as possible.

183. GROUNDING FRAMES AND CASES OF LIGHTNING ARRESTERS.

All noncurrent-carrying metal parts of arresters shall be grounded, unless effectively isolated by elevation or guarded as required for live parts of the voltage of the circuit to which the arrester is connected, and suitably identified as of that voltage, in accordance with rule 113.

184. GUARDING LIVE AND ARCING PARTS.

A. Protection From Contact or Arcing.

All current-carrying parts of arresters on circuits of more than 750 volts, unless effectively isolated by elevation, shall be adequately guarded to protect persons from inadvertent contact with them, or from injury by arcing, in accordance with rule 114.

B. Making Adjustments.

Lightning arresters, unless provided with disconnectors which are always opened before work is done on the arresters, shall be so arranged that necessary adjustments are possible (without approach to current-carrying parts) through the use of permanently grounded mechanisms or suitable insulating appliances. Where charging or adjusting must be done with arresters alive, permanently grounded mechanisms or suitable insulating appliances shall always be provided.

C. Insulation of Attachments.

All choke coils, gap electrodes, or other attachments, inherent to the lightning protective equipment, shall have an insulation from the ground or other conductors equal at least to the insulation demanded at other points of the circuit in the station.

PART 2. RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRIC SUPPLY AND COMMUNICATION LINES

CONTENTS

Page

Sec. 20. Scope, nature, and application of rules — 93
  200. Scope of rules — 93
    A. Extent of application — 93
    B. Not complete specifications — 93
    C. Conformity with good practice — 93
  201. Application of the rules and exemptions — 93
    A. Intent, modification — 93
    B. Realization of intent — 93
    C. Waiver for temporary installations — 94
    D. Waiver in emergencies — 94
  202. Minimum requirements — 94

Sec. 21. General requirements applying to overhead and underground lines — 94
  210. Design and construction — 94
  211. Installation and maintenance — 95
  212. Accessibility — 95
  213. Inspection and tests of lines and equipment — 95
    A. When in service — 95
      1. Initial compliance with rules — 95
      2. Inspection — 95
      3. Tests — 95
      4. Record of defects — 95
      5. Remedying defects — 95
    B. When out of service — 95
      1. Lines infrequently used — 95
      2. Lines temporarily out of service — 96
      3. Lines permanently abandoned — 96
  214. Isolation and guarding — 96
    A. Current-carrying parts — 96
    B. Noncurrent-carrying parts — 96
  215. Grounding of circuits and equipment — 96
    A. Methods — 96
    B. Parts to be grounded — 97
    C. Use of ground as part of circuit — 97
  216. Arrangement of switches — 97
    A. Accessibility — 97
    B. Indicating open or closed position — 98
    C. Locking — 98
    D. Uniform position — 98

Page

Sec. 22. Relations between various classes of lines 98
- 220. Relative levels 98
  - A. Standardization of levels 98
  - B. Relative levels—supply and communication conductors 98
    - 1. Preferred levels 98
    - 2. Minor extensions 99
    - 3. Special construction for supply circuits, the voltage of which is 550 volts or less and carrying power not in excess of 3,200 watts 99
  - C. Relative levels—supply lines of different voltage classifications 102
    - 1. At crossings or conflicts 102
    - 2. On poles used only by supply conductors 102
- 221. Avoidance of conflict 103
- 222. Joint use of poles by supply and communication circuits 103
  - A. Advantages 103
  - B. Cooperative study 103
  - C. Conditions under which joint use is desirable 103
- 223. Separate pole lines 104

Sec. 23. Clearances 104
- 230. General 104
  - A. Application 104
  - B. Constant-current circuits 105
  - C. Metal-sheathed supply cables 105
  - D. Neutral conductors 105
  - E. Maintenance of clearances 105
- 231. Horizontal clearances of supporting structures from other objects 105
  - A. From fire hydrants 105
  - B. From street corners 106
  - C. From curbs 106
  - D. From railroad tracks 106
- 232. Vertical clearance of wires above ground or rails 106
  - A. Basic clearances 107
  - B. Increased clearances 110
    - 1. Spans longer than specified in rule 232, A, 2 110
    - 2. Voltages exceeding 50,000 volts between conductors 112
    - 3. Conductors supported by suspension-type insulators at crossings over track rails 112
    - 4. Methods of avoiding this increase of clearance 113
  - C. Supply pole wiring at underground risers 113

Sec. 23. Clearances—Continued. Page
- 233. Wire-crossing clearances 114
  - A. Basic clearances 114
  - B. Increased clearances 116
    - 1. Crossing spans longer than specified in rule 233, A, 2 116
    - 2. Voltages exceeding 50,000 volts between conductors 118
    - 3. Conductors supported by suspension-type insulators at crossings over communication wires 118
    - 4. Methods of avoiding this increase of clearance 119
- 234. Clearances of conductors of one line from other conductors and structures 119
  - A. Clearances from conductors of another line 119
  - B. Clearances from supporting structures of another line 120
  - C. Clearances from buildings 120
    - 1. General 120
    - 2. Ladder space 120
    - 3. Open supply conductors attached to buildings 121
    - 4. Conductors passing by or over buildings 121
      - (a) Minimum clearances 121
      - (b) Guarding of supply conductors 122
  - D. Clearances from bridges 123
    - 1. Clearances of conductors from bridges 123
    - 2. Guarding trolley-contact conductors located under bridges 123
      - (a) Where guarding is required 123
      - (b) Nature of guarding 124
- 235. Minimum line-conductor clearances and separations at supports 124
  - A. Separation between conductors on pole lines 124
    - 1. Application of rule 124
      - (a) Multiconductor wires or cables 124
      - (b) Conductors supported by messengers or span wires 124
      - (c) Measurement of clearances 124

Sec. 23. Clearances—Continued.

Page

235. Minimum line-conductor clearances and separations at supports—Continued.
    - A. Separation between conductors on pole lines—Continued.
        - 2. Horizontal separations between line conductors 124
            - (a) Fixed supports 124
                - (1) Minimum horizontal separation between line conductors of the same or different circuits 125
                - (2) Separations according to sags 126
            - (b) Suspension insulators not restrained from movement 127
        - 3. Clearances in any direction from line conductors to supports, and to vertical or lateral conductors, span or guy wires, attached to the same support 127
            - (a) Fixed supports 127
            - (b) Suspension insulators not restrained from movement 129
        - 4. Conductor separation—vertical racks 129
        - 5. Separation between supply circuits of different voltage classifications on the same crossarm 130
    - B. Separation between conductors attached to buildings 130
    - C. Separation between conductors attached to bridges 131

236. Climbing space 131
    - A. Location and dimensions 131
    - B. Portions of supporting structures in climbing space 131
    - C. Crossarm location relative to climbing space 131
    - D. Location of supply apparatus relative to climbing space 132
    - E. Climbing space through conductors on crossarms 132
        - 1. Conductors of same voltage classification on same crossarm 132
        - 2. Conductors of different voltage classification on same crossarm 132
        - 3. Horizontal climbing-space dimensions 133

Sec. 23. Clearances—Continued.

236. Climbing space—Continued. Page
- F. Climbing space on buckarm construction 133
- G. Climbing space for longitudinal runs 134
- H. Climbing space past vertical conductors 135
- I. Climbing space near ridge-pin conductors 135

237. Working space 135
- A. Location of working spaces 135
- B. Dimensions of working spaces 135
  - 1. Along the crossarm 135
  - 2. Perpendicular to the crossarm 135
  - 3. Vertically 135
- C. Location of vertical and lateral conductors relative to working spaces 136
- D. Location of buckarms relative to working spaces 136
  - 1. Standard height of working space 136
  - 2. Reduced height of working space 136

238. Vertical separation between line conductors, cables, and equipment located at different levels on the same pole or structure 137
- A. Vertical separation between horizontal crossarms 137
  - 1. Basic separations 137
  - 2. Increased separations for voltages exceeding 50,000 volts between conductors 139
- B. Vertical separation between line conductors on horizontal crossarms 139
  - 1. Where conductors on the crossarm are of the same voltage classification 139
  - 2. Where conductors of different voltage classifications are on same crossarm 140
  - 3. Conductors of different sags on same support 140
    - (a) Variation in clearance 140
    - (b) Readjustment of sags 140
- C. Separation in any direction 140
- D. Vertical separation for line conductors not carried on crossarms 141
- E. Vertical separation between conductors and noncurrent-carrying metal parts of equipment 141
  - 1. Equipment 141
  - 2. Separations in general 141
  - 3. Separations for span wires and brackets 142

Sec. 23. Clearances—Continued.

Page
- 239. Clearances of vertical and lateral conductors from other wires and surfaces on the same support 142
  - A. Location of vertical or lateral conductors relative to climbing spaces, working spaces, and pole steps 143
  - B. Conductors not in conduit 143
  - C. Mechanical protection near ground 143
  - D. Requirements for vertical and lateral supply conductors on supply line poles or within supply space on jointly used poles 144
    - 1. General clearances 144
    - 2. Special cases 145
      - (a) Side-arm construction 145
      - (b) On insulators 145
      - (c) Conductors to street lamps 146
      - (d) Conductors of less than 300 volts 146
      - (e) Other conditions 146
  - E. Requirements for vertical and lateral communication conductors on communication line poles or within the communication space on jointly used poles 147
    - 1. Clearances from wires 147
    - 2. Clearances from pole and crossarm surfaces 147
  - F. Requirements for vertical supply conductors passing through communication space on jointly used poles 148
    - 1. Metal-sheathed supply cables 148
      - (a) Extent of covering 148
      - (b) Nature of covering 148
    - 2. Supply conductors 149
      - (a) In conduit 149
      - (b) On pins and insulators 149
      - (c) Installed on the pole surface 149
      - (d) Suspended from supply cross arm 150
    - 3. Supply grounding wires 150
    - 4. Separation from through bolts 151
  - G. Requirements for vertical communication conductors passing through supply space on jointly used poles 151
    - 1. Metal-sheathed communication cables 151
    - 2. Communication conductors 152
    - 3. Communication grounding conductors 152
    - 4. Separation from through bolts 152

Page

Sec. 24. Grades of construction 153
- 240. General 153
- 241. Application of grades of construction to different situations 153
  - A. Supply cables 153
    - 1. Specially installed cables 153
    - 2. Other cables 153
  - B. Two or more conditions 153
  - C. Order of grades 153
  - D. At crossings 154
    - 1. Grade of upper line 154
    - 2. Grade of lower line 154
    - 3. Multiple crossings 154
      - (a) Where a line crosses in one span over two other lines 154
      - (b) Where one line crosses over a span in another line, which span is in turn involved in a second crossing 154
      - (c) Where communication conductors cross over supply conductors and railroad tracks in the same span 155
  - E. Conflicts 155
    - 1. How determined 155
    - 2. Conductor conflict 156
    - 3. Structure conflict 156
- 242. Grades of construction for conductors 156
  - A. Status of constant-current circuits 156
  - B. Status of railway feeders and trolley-contact conductors 156
  - C. Status of communication circuits used exclusively in the operation of supply lines 157
  - D. Status of fire-alarm conductors 157
  - E. Status of neutral conductors of supply circuits 157
- 243. Grades of supporting structures 159
  - A. Poles or towers 159
  - B. Crossarms 160
  - C. Pins, insulators, and conductor fastenings 160

Sec. 25. Loading for grades B, C, and D 161
- 250. General loading map 161
- 251. Conductor loading 163
- 252. Loads upon line supports 164
  - A. Assumed vertical loading 164
  - B. Assumed transverse loading 164
    - 1. Heavy loading (H) 165
    - 2. Medium loading (M) 165
    - 3. Light loading (L) 165

Sec. 25. Loading for grades B, C, and D—Continued.
  252. Loads upon line supports—Continued.
    B. Assumed transverse loading—Continued. Page
      4. Trolley-contract conductors 166
      5. Flat surfaces 166
      6. At angles (combined longitudinal and transverse loading) 166
    C. Assumed longitudinal loading 166
      1. Change in grade of construction 166
      2. Jointly used poles at crossings over railroads or communication lines 167
      3. Dead ends 167
      4. Communication conductors on unguyed supports at railroad crossings 167
    D. Average span lengths 168
      1. General 168
      2. Crossings 168
    E. Simultaneous application of loads 168
Sec. 26. Strength requirements 168
  260. Preliminary assumptions 168
  261. Grades B and C construction 169
    A. Poles and towers 169
      1. Average strength of three poles 169
      2. Reinforced-concrete poles 169
      3. Steel supporting structures 170
        (a) Vertical and transverse strength 170
        (b) Longitudinal strength 170
        (c) Minimum strength 171
        (d) Strength at angles in a line 171
        (e) Thickness of steel 172
        (f) Unsupported length of compression members 172
        (g) General construction features 172
        (h) Protective covering or treatment 173
      4. Wood poles 173
        (a) Transverse strength 173
        (b) Longitudinal and dead-end strength 173
        (c) Ultimate fiber stress 175
        (d) Allowable percentages of ultimate stress 175
        (e) Freedom from defects 176
        (f) Minimum pole sizes 176
        (g) Spliced and stub-reinforced poles 176
      5. Transverse-strength requirements for structures where side guying is required, but can only be installed at a distance 177

Sec. 26. Strength requirements—Continued.
  261. Grades B and C construction—Continued.
    A. Poles and towers—Continued.
      6. Longitudinal-strength requirements for sections of higher grade in lines of a lower grade of construction — Page 178
        (a) Methods of providing longitudinal strength — 178
        (b) Flexible supports — 179
      7. Strength at angles in a line — 179
    B. Foundations — 180
      1. Use of foundations — 180
        (a) Wood and reinforced-concrete poles — 180
        (b) Steel poles or towers — 180
      2. Strength of foundations — 180
        (a) Steel supports — 180
        (b) Wood and concrete poles — 180
    C. Guys — 180
      1. General — 180
      2. For poles in insecure earth — 180
      3. On steel structures — 181
      4. On wood or concrete poles — 181
      5. Strength of guys — 181
    D. Crossarms — 182
      1. Vertical strength — 182
      2. Bracing — 182
      3. Longitudinal strength — 182
        (a) General — 182
        (b) At dead-ends and at ends of higher-grade construction in line of lower grade — 183
        (c) At ends of transversely weak sections — 183
        (d) Methods of meeting rules 261, D, 3, (b) and (c) — 183
      4. Dimensions of crossarms of selected yellow pine or fir — 184
      5. Double crossarms or brackets — 184
      6. Location — 185
    E. Pins and conductor fastenings — 185
      1. Longitudinal strength — 185
        (a) General — 185
        (b) At dead-ends and at ends of higher-grade construction in line of lower grade — 185
        (c) At ends of transversely weak sections — 185
        (d) Methods of meeting rules 261, E, 1, (b) and (c) — 186

Sec. 26. Strength requirements—Continued.

261. Grades B and C construction—Continued.

E. Pins and conductor fastenings—Con.

Page
2. Sharp edges on fastenings 186
3. Height of pin 186
4. Double pins and conductor fastenings 187
F. Open supply conductors 187
1. Material 187
2. Minimum sizes of supply conductors 188
3. Lightning protection wires 188
4. Sags and tensions 189
5. Splices and taps 189
6. Trolley-contact conductors 189
G. Supply cables 190
1. Specially installed supply cables 190
(a) Messengers 190
(b) Grounding of cable sheath and messenger 190
(c) Cable splices 190
(d) Cable insulation 190
2. Other supply cables 191
(a) Messenger 191
(b) Cable 191
H. Open-wire communication conductors 191
I. Communication cables 191
1. Metal-sheathed communication cables 191
2. Messenger 191
J. Paired communication conductors 192
1. Paired conductors supported on messenger 192
(a) Use of messenger 192
(b) Sag of messenger 192
(c) Size and sag of conductors 192
2. Paired conductors not supported on messenger 192
(a) Above supply lines 192
(b) Above trolley-contact conductors 193
K. Short-span crossing construction 193
L. Cradles at supply-line crossings 194
M. Protective covering or treatment for metal work 194
262. Grade D construction 194
A. Poles 194
1. Strength of unguyed poles 194
2. Strength of guyed poles 194
3. Strength requirements for poles where guying is required but can only be installed at a distance 195

Sec. 26. Strength requirements—Continued.
262. Grade D construction—Continued.
A. Poles—Continued.

Page
4. Pole locations at crossings 195
5. Freedom from defects 195
6. Minimum pole size 196
7. Spliced and stub-reinforced poles 196
8. Poles located at crossings over spur tracks 196
B. Pole settings 196
C. Guys 196
1. General 196
2. Where used 197
3. Guys used for transverse strength 199
4. Guys used for longitudinal strength 199
(a) Direction of head guys 199
(b) Size and number of head guys 199
5. Maintenance 199
D. Crossarms 199
1. Material 199
2. Minimum size 199
(a) Wood crossarms 199
(b) Steel or iron crossarms 200
3. Double crossarms 200
E. Brackets and racks 200
F. Pins 200
1. Material 200
2. Strength 200
3. Size 200
(a) Wood pins 200
(b) Metal pins 200
G. Insulators 200
H. Attachment of conductor to insulator 201
I. Conductors 201
1. Material 201
2. Size 201
(a) Spans not exceeding 150 feet 201
(b) Spans exceeding 150 feet 201
3. Paired conductors without messengers 202
(a) Material and strength 202
(b) Limiting span lengths 202
4. Sags 202
5. Splices and taps 203
J. Messengers 203
1. Minimum size 203
(a) Spans not exceeding 150 feet 203
(b) Spans exceeding 150 feet 204
2. Sags and tensions 204
K. Inspection 204

Sec. 26. Strength requirements—Continued. Page
263. Grade N construction 204
A. Poles and towers 204
B. Guys 204
C. Crossarm strength 205
D. Supply-line conductors 205
1. Material 205
2. Size 205
E. Supply services 206
1. Material 206
2. Size of open-wire services 206
(a) Not over 750 volts between conductors 206
(b) Exceeding 750 volts between conductors 207
3. Sag, open-wire services 207
(a) Not over 750 volts between conductors 207
(b) Exceeding 750 volts between conductors 207
4. Cabled services 207
(a) Size 207
(b) Sag 207
(c) Insulation 208
F. Lightning-protection wires 208
G. Trolley-contact conductors 208
H. Cradles at supply-line crossings 208
I. Communication conductors 208
Sec. 27. Line insulators 208
270. Application of rule 208
271. Material and marking 208
272. Electrical strength of insulators in strain position 209
273. Ratio of flash-over to puncture voltage 209
274. Test voltages 209
275. Factory tests 209
276. Selection of insulators 210
A. Insulators for constant-current circuits 210
B. Insulators for single-phase circuits directly connected to three-phase circuits 210
C. Insulators for nominal voltages between conductors 210
277. Protection against arcing 211
278. Compliance with rule 277 at crossings 211
Sec. 28. Miscellaneous requirements 213
280. Supporting structures for overhead lines 213
A. Poles and towers 213
1. Rubbish 213
2. Guarding poles 213
(a) Protection against mechanical injury 213
(b) Protection against climbing 213

Sec. 28. Miscellaneous requirements—Continued.

280. Supporting structures for overhead lines—Con.

A. Poles and towers—Continued.

	Page
3. Warning signs	213
(a) On poles or towers	213
(b) On bridge fixtures	213
4. Grounding metal poles	214
5. Pole steps	214
(a) Metal steps	214
(b) Wood blocks	214
6. Identification of poles	214
7. Obstructions	215
B. Crossarms	215
1. Location	215
2. Bracing	215
C. Unusual conductor supports	215
281. Tree trimming	216
A. General	216
B. At wire crossings and railroad crossings	216
282. Guying	216
A. Where used	216
B. Strength	216
C. Point of attachment	217
D. Guy fastenings	217
E. Guy guards	217
F. Insulating guys from metal poles	217
G. Anchor rods	218
H. Grounding	218
283. Insulators in guys attached to poles and towers	218
A. Properties of guy insulators	218
1. Material	218
2. Electrical strength	218
3. Mechanical strength	218
B. Use of guy insulators	219
1. One insulator	219
2. Two insulators	219
3. Relative location of insulators in guys located one above the other	220
4. Grounding of guys	220
284. Span-wire insulators	220
A. Mechanical strength	220
B. Use of span-wire insulators	220
285. Overhead conductors	221
A. Identification	221
B. Branch connections	221
1. Accessibility	221
2. Clearance	221
C. Common neutral	221

Sec. 28. Miscellaneous requirements—Continued. Page

- 286. Equipment on poles 222
  - A. Identification 222
  - B. Location 222
  - C. Guarding 222
  - D. Hand clearance 222
  - E. Street-lighting equipment 223
    - 1. Clearances from pole surface 223
    - 2. Clearances above grounds 223
    - 3. Horizontal clearance 223
    - 4. Material of suspension 223
    - 5. Insulators in suspension ropes 224
    - 6. Arc-lamp disconnectors 224
    - 7. Grounding lamp posts 224
  - F. Transformers 224
- 287. Protection for exposed overhead communication lines 224
  - A. Open wire 224
  - B. Metal-sheathed cable 225
- 288. Circuits of one class used exclusively in the operation of circuits of another class 225
  - A. Overhead communication circuits used exclusively in the operation of supply circuits 225
    - 1. Choice of method 225
    - 2. Guarding 225
    - 3. Where ordinary communication line construction may be used 225
    - 4. Where supply-line construction must be used 226
  - B. Supply circuits used exclusively in the operation of communication circuits 227
    - 1. Where run in open wire 227
    - 2. Where run in aerial or underground cable—(See also sec. 29) 227
- 289. Overhead electric railway construction 228
  - A. Trolley-contact conductor supports 228
  - B. High-voltage contact conductors 228
  - C. Third rails 228
  - D. Prevention of loss of contact at railroad crossings 229
  - E. Guards under bridges 229
    - 1. Where guarding is required 229
    - 2. Nature of guarding 229

Sec. 29. Rules for underground lines.—(See also rule 288, B, 2) 230

- 290. Location 230
  - A. General location 230
  - B. Ducts 230
  - C. Manholes 230

Sec. 29. Rules for underground lines—Continued.

Page
291. Construction of duct and cable systems 230
    A. Material, size, and finish of ducts 230
    B. Grading of ducts 230
    C. Settling 230
    D. Clearance 231
        1. General 231
        2. Below base of rail 231
        3. Iron pipe conduit 232
    E. Separations between supply and communication duct systems 232
        1. General 232
        2. Entering manholes 233
    F. Duct entrances into manholes 233
    G. Sealing laterals 233
    H. Duct arrangement for dissipation of heat 233
292. Construction of manholes 234
    A. Minimum strength 234
    B. Dimensions 234
        1. Width 234
        2. Working space 234
    C. Drainage 234
    D. Ventilation 234
    E. Manhole openings 235
    F. Manhole covers 235
    G. Supports for cables 235
    H. Manhole location 235
293. Location of cables 235
    A. Accessibility 235
    B. Cables carrying large currents 235
    C. Separation between conductors 235
        1. Cables of different voltages 235
        2. Cables of different systems 236
        3. Cables of supply and communication systems 236
            (a) General 236
            (b) In the same manhole 236
294. Protection and separation of conductors buried in earth 237
    A. Separation 237
    B. Protection at crossing of cables 237
    C. Protection of cables installed parallel 237
295. Protection of conductors in duct systems and manholes 238
    A. Protection against arcing 238
    B. Bonding 238
296. Guarding of live parts in manholes 239
    A. Conductor joints or terminals 239
    B. Apparatus 239

Sec. 29. Rules for underground lines—Continued. Page
297. Construction at risers from underground 239
    A. Separation between risers of communication and supply systems 239
    B. Mechanical protection of conductors 239
    C. Grounding of riser pipes 239
    D. Conductor terminal construction 240
        1. Protection against moisture 240
        2. Insulation of conductors 240
    E. Clearance above ground for open supply wiring 240
298. Identification of conductors 240
299. Identification of apparatus connected in multiple 241

SEC. 20. SCOPE, NATURE, AND APPLICATION OF RULES

200. Scope of Rules.

A. Extent of Application.

The following rules apply to electric supply and communication lines in overhead and underground construction whether operated in connection with public utilities, privately or municipally owned, with industrial establishments, or otherwise.

B. Not Complete Specifications.

These rules are not complete specifications but are intended to embody the requirements which are most important from the standpoint of safety to employees and the public.

C. Conformity with Good Practice.

Construction should be made according to accepted good practice for the given local conditions in all particulars not specified in the rules.

201. Application of the Rules and Exemptions.

A. Intent, Modification.

The rules shall apply to all installations except as modified or waived by the proper administrative authority. They are intended to be so modified or waived whenever they involve expense not justified by the protection secured or for any other reasons are impracticable; or whenever equivalent or safer construction can be more readily provided in other ways.

B. Realization of Intent.

The intent of the rules will be realized:

1. By applying the rules in full to all new installations, reconstructions, and extensions, except where for special reasons any rule is shown to be impracticable or where the advantage of uniformity with existing construction is greater than the advantage of construction in conformity with the rules.

201. **Realization of Intent**—Continued.

2. By placing guards on existing installations or otherwise bringing them into compliance with the rules, except where the expense involved is not justifiable.

Note: The time allowed for bringing existing installations into compliance with the rules as specified in 2 will be determined by the proper administrative authority.

C. Waiver for Temporary Installations.

It will sometimes be necessary to modify or waive certain rules in cases of temporary installations or installations which are soon to be discarded or reconstructed.

D. Waiver in Emergencies.

In case of emergency or pending decision of the administrator, the person responsible for the installation may decide as to modification or waiver of any rule, subject to review by proper authority, but shall first notify all parties directly concerned in advance of construction.

202. MINIMUM REQUIREMENTS.

The rules state the minimum requirements for spacings, clearances, and strength of construction. More ample spacings and clearances or greater strength of construction may be provided if other requirements are not neglected in so doing.

Note: Some of these minimum values are exceeded in much existing construction; service requirements frequently call for stronger supports and higher factors of safety than the minimum requirements of these rules.

SEC. 21. GENERAL REQUIREMENTS APPLYING TO OVERHEAD AND UNDERGROUND LINES

210. DESIGN AND CONSTRUCTION.

All electric supply and communication lines and equipment shall be of suitable design and construction for the service and conditions under which they are to be operated.

211. INSTALLATION AND MAINTENANCE.

All electric supply and communication lines and equipment shall be installed and maintained so as to reduce hazards to life as far as practicable.

212. ACCESSIBILITY.

All parts which must be examined or adjusted during operation shall be arranged so as to be readily accessible to authorized persons by the provision of adequate climbing spaces, working spaces, working facilities, and clearances between conductors.

213. INSPECTION AND TESTS OF LINES AND EQUIPMENT.

A. When in Service.

1. INITIAL COMPLIANCE WITH RULES.

Lines and equipment shall comply with these safety rules upon being placed in service.

2. INSPECTION.

Lines and equipment shall be systematically inspected from time to time by the person responsible for the installation.

3. TESTS.

Lines and equipment shall be subjected, when necessary, to tests which will determine their fitness for service.

4. RECORD OF DEFECTS.

Any defects revealed by inspection, if not promptly corrected, shall be recorded.

5. REMEDYING DEFECTS.

Defective lines and equipment shall be put in good order or effectively disconnected.

B. When Out of Service.

1. LINES INFREQUENTLY USED.

Supply lines and equipment infrequently used shall be inspected to see that they are in safe condition for service.

213. B. When Out of Service—Continued.

2. LINES TEMPORARILY OUT OF SERVICE.

Lines temporarily out of service shall be maintained in such condition that a hazard will not be created.

3. LINES PERMANENTLY ABANDONED.

Lines permanently abandoned shall be removed or maintained in a safe condition.

Note: Overhead service drops to consumers are often disconnected without removal when the service is discontinued. This is considered good practice when it is undesirable to remove the service drop entirely.

214. ISOLATION AND GUARDING.

A. Current-carrying Parts.

To promote safety to the general public and to employees not authorized to approach conductors and other current-carrying parts of electric supply lines, such parts shall be arranged so as to provide adequate clearance from the ground or other space generally accessible, or shall be provided with guards so as to isolate them effectively from accidental contact by such persons.

B. Noncurrent-carrying Parts.

Ungrounded metal-sheathed service cables, service conduits, metal fixtures, and similar noncurrent-carrying parts, if located in urban districts and where liable to become charged to more than 300 volts to ground, shall be isolated or guarded so as not to be exposed to accidental contact by unauthorized persons.

As an alternative to isolation or guarding, grounding of certain noncurrent-carrying parts is permitted by rule 215, B, and rule 280, A, 4.

215. GROUNDING OF CIRCUITS AND EQUIPMENT.

A. Methods.

The methods to be used for effective grounding for lightning arresters of supply lines, for circuits,

215. A. Methods.—Continued.

for equipment and for wire raceways are given in section 9. The methods to be used for grounding of lightning arresters of communication lines are specified in rule 392, part 3 of this code.

B. Parts to be Grounded.

In urban districts metal conduits, cable sheaths, metal lamp posts, and frames, cases, and hangers of equipment shall be effectively grounded.

Exception 1: This rule does not apply when such parts are guarded from accidental contact by unauthorized persons.

Exception 2: This rule does not apply where such parts are 8 feet or more above the ground.

Exception 3: This rule does not apply to metal conduit and cable sheaths inclosing communication conductors, or supply conductors of not more than 300 volts to ground, provided such conduit and sheaths are not exposed to probable contact with circuits of more than 300 volts to ground.

Recommendation: It is recommended that supply cables have the sheath bonded to any conduit extending above the ground surface.

Note: Metal conduit above ground which contains extensions from metal-sheathed underground cable is considered to be sufficiently grounded by the cable sheath, provided such sheath is in good contact with the earth or is connected to a good ground. (For method of grounding see section 9.)

C. Use of Ground as Part of Circuit.

In urban districts supply circuits shall not be designed to use the ground normally as the sole conductor for any part of the circuit.

Recommendation: It is recommended that such use be avoided in rural districts.

216. ARRANGEMENT OF SWITCHES.

A. Accessibility.

All switches shall be readily accessible to authorized persons.

216. Arrangement of Switches—Continued.

B. Indicating Open or Closed Position.

All switches shall indicate clearly whether they are open or closed.

C. Locking.

Pole-top switches accessible to unauthorized persons shall have provision for locking in both open and closed positions.

D. Uniform Position.

The handles or control mechanism for all switches throughout any system shall have so far as practicable the same position when open and a uniformly different position when closed, in order to minimize operating errors. Where it is advisable to depart from this practice, the switches should be marked so as to minimize the liability to mistakes in operation.

SEC. 22. RELATIONS BETWEEN VARIOUS CLASSES OF LINES

220. Relative Levels.

A. Standardization of Levels.

The levels at which different classes of conductors are to be located should be standardized where practicable for any given community by agreement of the utilities concerned.

Note: This practice facilitates the extension of lines and promotes the safety of the public and workers by permitting the relative levels and required clearances to be readily obtained on jointly or commonly used poles as well as at crossings and conflicts.

B. Relative Levels—Supply and Communication Conductors.

1. PREFERRED LEVELS.

Where supply and communication conductors cross each other or are in conflict, or are located on the same poles or towers, the supply conduc-

220. B. Relative Levels—Supply and Communication Conductors—Continued.

tors shall preferably be carried at the higher level.

Exception: This does not apply to trolley feeders which may be located for convenience approximately at the level of the trolley contact conductor.

Note: Supply lines generally use larger conductors than communication lines so there is less liability of contact between the two if the supply conductors are located in the upper position. This relative location also avoids the necessity of workmen on communication conductors passing through supply conductors and working above them and avoids the necessity of increasing the grade of construction required for communication conductors.

2. MINOR EXTENSIONS.

In localities where the practice of placing conductors of communication circuits for public use above supply conductors has been generally established, minor extensions may be made in either system, keeping the conductors in the same relative position. These extensions should not continue beyond a location at which it becomes practicable to change to the arrangement standardized by these rules.

3. SPECIAL CONSTRUCTION FOR SUPPLY CIRCUITS, THE VOLTAGE OF WHICH IS 550 VOLTS OR LESS AND CARRYING POWER NOT IN EXCESS OF 3,200 WATTS.

Where all circuits are owned or operated by one party or where cooperative consideration determines that the circumstances warrant and the necessary coordinating methods are employed, single-phase alternating-current or two-wire direct-current circuits carrying a voltage of 550 volts or less between conductors, with transmitted power not in excess of 3,200 watts, when involved in the joint use of poles with com-

220. B. Relative Levels—Supply and Communication Conductors—Continued.

munication circuits, may be installed in accordance with footnote 8 (3) of table 1 in rule 232, A and footnote (1) of table 11 in rule 238, A, 1, under the following conditions:

(a) That such supply circuits are of wire having a good grade of commercial double-braid weatherproof covering not smaller than No. 8 AWG medium hard-drawn copper or its equivalent in strength, and the construction otherwise conforms with the requirements for supply circuits of the same class.

(b) That the supply circuits be placed on the end and adjacent pins of the lowest through signal crossarm and that a 30-inch climbing space be maintained from the ground up to a point at least 24 inches above the supply circuits. The supply circuits shall be rendered conspicuous by the use of insulators of different form or color from others on the pole line or by stenciling the voltage on each side of the crossarm between the pins carrying each supply circuit, or by indicating the voltage by means of metal characters.

(c) That there shall be a vertical clearance of at least 2 feet between the crossarm carrying these supply circuits and the next crossarm above. The other pins on the crossarm carrying the supply circuits may be occupied by communication circuits used in the operation or control of a signal system or other supply system if owned, operated and maintained by the same company operating the supply circuits.

(d) That such supply circuits shall be equipped with arresters and fuses installed in the supply end of the circuit and where the

220. B. Relative Levels—Supply and Communication Conductors—Continued.

signal circuit is alternating current, the protection shall be installed on the secondary side of the supply transformer. The arresters shall be designed so as to break down at approximately twice the voltage between the wires of the circuit, but the break-down voltage of the arrester need not be less than 1,000 volts. The fuses shall have a rating not in excess of approximately twice the maximum operating current of the circuit, but their rating need not be less than 10 amperes. The fuses likewise shall in all cases have a rating of at least 600 volts, and where the supply transformer is a step-down transformer, shall be capable of opening the circuit successfully in the event the transformer primary voltage is impressed upon them.

(e) Such supply circuits when enclosed in effectively grounded metal-sheathed cable, or other cables carried on effectively grounded messenger, may be carried on a pole below communication attachments, with not less than 2 ft vertical separation between the supply cable and the lowest communication crossarm. Communication circuits other than those used in connection with the operation of the supply circuits shall not be carried in the same cable with such supply circuits.

(f) Where such supply conductors are carried below communication conductors, transformers and other apparatus associated therewith shall be attached only to the sides of the crossarm in the space between and at no higher level than, such supply wires.

(g) Lateral runs of such supply circuits carried in a position below the communication space

220. B. Relative Levels—Supply and Communication Conductors—Continued.

shall be protected through the climbing space by wood molding or equivalent covering, or shall be carried in multiple-conductor cable having a suitable substantial insulating covering, and such lateral runs shall be placed on the under side of the crossarm.

C. Relative Levels—Supply Lines of Different Voltage Classifications (as classified in table 11).

1. AT CROSSINGS OR CONFLICTS.

Where supply conductors of different voltage classifications cross each other or are in conflict, the higher-voltage lines shall preferably be carried at the higher level.

2. ON POLES USED ONLY BY SUPPLY CONDUCTORS.

Where supply conductors of different voltage classifications are on the same poles, relative levels should be as follows:

(a) Where all circuits are owned by one utility, the conductors of higher voltages should generally be placed above those of lower voltage.

Note: These relative levels will often avoid the necessity of increasing the grade of construction for crossarms, pins, and conductor fastenings of the lower-voltage conductors.

(b) Where different circuits are owned by separate utilities, the circuits of each utility may be grouped together and one group of circuits may be placed above the other group provided that the circuits in each group are located so that those of higher voltage are at the higher levels and that either of the following conditions is met:

(1) A vertical spacing of not less than 4 feet (or 6 feet where required by table 11,

220. C. Relative Levels—Supply Lines of Different Voltage Classifications—Continued.

rule 238, A, 1) is maintained between the nearest line conductors of the respective utilities (this space to be identified if necessary as a division space).

(2) Conductors of a lower voltage classification are at a higher level than those of a higher classification only where on the opposite side of the pole.

221. AVOIDANCE OF CONFLICT.

Two parallel pole lines, either of which carries supply conductors, shall where practicable be so separated from each other that neither conflicts with the other. If this is impracticable, then the conflicting line or lines shall be built of the grade of construction required by section 24 for a conflicting line or the two lines shall be combined in a single pole line.

222. JOINT USE OF POLES BY SUPPLY AND COMMUNICATION CIRCUITS.

A. Advantages.

Joint use of poles under suitable conditions and with certain types of circuits offers many advantages and promotes safety.

B. Cooperative Study.

Joint use involves contractual relations between utilities, consideration of service requirements, and economies as well as safety. It, therefore, requires cooperative study by the utilities concerned.

C. Conditions Under Which Joint Use is Desirable.

In the case of local or distribution circuits along the same highway or similar right-of-way, where, under the provisions of section 24 applying to joint use, grade C construction or less would be required, joint use is generally preferable to separate pole lines

222. C. Conditions Under Which Joint Use is Desirable—Continued.

(except sometimes in rural districts) unless the number of conductors is very large or the character of the circuits makes joint use undesirable.

Where circuits other than those mentioned above are involved, the choice between joint use of poles and separate pole lines shall be determined through cooperative consideration, by the utilities concerned, of all the factors involved, including the character of circuits, the total number and weight of conductors, tree conditions, number and location of branches and service drops, availability of right of way, etc. Where such joint use is mutually agreed upon, it shall be subject to the appropriate grade of construction as specified in section 24. Where such joint use is not employed, separate lines as specified in rule 223 shall be used.

In any event, joint use is preferable to separate lines where it would be impracticable to avoid an overbuilt conflict with separate lines.

223. Separate Pole Lines.

Where two separate pole lines are to be used, one of which carries supply conductors and the other communication conductors, they shall be separated, if practicable, so that neither conflicts with the other, but if within conflicting distance, they shall be separated as far as practicable and shall be built of the grade of construction required by section 24.

SEC. 23. CLEARANCES

230. General.

A. Application.

This section covers all clearances, including separations and climbing spaces, involving poles and wires. Clearances of lamps from pole surfaces, from spaces accessible to the general public, and height above ground are covered in rule 286, E.

230. General—Continued.

B. Constant-Current Circuits.

The clearances for constant-current circuits shall be determined on the basis of their nominal full-load voltage.

C. Metal-Sheathed Supply Cables.

As far as clearances are concerned, effectively grounded continuous metal-sheathed supply cables of all voltages and any supply cables supported on effectively grounded messengers, are classified the same as open supply wires of 0 to 750 volts between conductors.

D. Neutral Conductors.

Neutral conductors of supply circuits shall have the same clearances as the phase wires of the circuit with which they are associated, except that neutral conductors which are effectively grounded throughout their length and associated with circuits of 750 to 15,000 volts between conductors may have the same clearances as circuits of 0 to 750 volts between conductors.

E. Maintenance of Clearances.

The clearances required by this section shall be maintained at the specified values.

231. HORIZONTAL CLEARANCES OF SUPPORTING STRUCTURES FROM OTHER OBJECTS.

Poles, towers, and other supporting structures and their guys and braces shall have the following horizontal clearances from other objects. The clearance shall be measured between the nearest parts of the objects concerned.

A. From Fire Hydrants.

Not less than 3 feet.

Recommendation: Where conditions permit, a clearance of not less than 4 feet is recommended.

231. Horizontal Clearances of Supporting Structures from Other Objects—Continued.

B. From Street Corners.

Where hydrants are located at street corners, poles and towers should not be set so far from the corners as to make necessary the use of flying taps inaccessible from the poles.

C. From Curbs.

Not less than 6 inches measured to the street side of the curb.

D. From Railroad Tracks.

Where railroad tracks are paralleled or crossed by overhead lines, the poles shall, if practicable, be located not less than 12 feet from the nearest track rail.

Exception 1: At sidings a clearance of not less than 7 feet may be allowed, provided sufficient space for a driveway be left where cars are loaded or unloaded.

Exception 2: Supports for overhead trolley contact conductors may be located as near their own track rail as conditions require. If very close, however, permanent screens on cars will be necessary to protect passengers.

Exception 3: Where necessary to provide safe operating conditions which require an uninterrupted view of signals, signs, etc., along tracks, the parties concerned shall cooperate in locating poles to provide the necessary clearance where practicable.

232. VERTICAL CLEARANCE OF WIRES ABOVE GROUND OR RAILS.

The vertical clearance of all wires above ground in generally accessible places or above rails shall be not less than the following:

232. Vertical Clearance of Wires Above Ground or Rails—Continued.

A. Basic Clearances.

The clearances in table 1 apply under the following conditions:

1. Temperature of 60° F, no wind, with final unloaded sag in the wire, or with initial unloaded sag in cases where wires are maintained approximately at initial unloaded sags.
2. Span lengths not greater than the following:

Loading district	Span lengths
	Feet
Heavy	[a]175
Medium	[a]250
Light	350

[a] 150 feet in heavy-loading district and 225 feet in medium-loading district for 3-strand conductors, each wire of which is 0.09 inch or less in diameter.

3. Voltages 0 to 50,000 volts between conductors.
4. Fixed supports for the conductor or wire.

(For other conditions, see rule 232, B.)

232. A. Basic Clearances—Continued.

TABLE 1.—*Minimum vertical clearance of wires above ground or rails*

[All voltages are between wires unless otherwise stated. Supply wires include trolley feeders]

Nature of ground or rails underneath wires	Guys; messengers; communication, span, and lightning protection wires; effectively grounded continuous-metal-sheath cables of all voltages	Open supply line wires, arc wires and service drops			Trolley contact conductors and associated span or messenger wires [1]	
		0 to 750 volts	750 to 15,000 volts[14]	15,000 to 50,000 volts	0 to 750 volts to ground	Exceeding 750 volts to ground
WHERE WIRES CROSS OVER						
Track rails of railroads (except electrified railroads using overhead trolley conductors) handling freights cars on top of which men are permitted[2][16]	*Feet* [3][15] 27	*Feet* [3] 27	*Feet* [3] 28	*Feet* 30	*Feet* [4] 22	*Feet* [4] 22
Track rails of railroads (except electrified railroads using overhead trolley conductors) not included above [2]	18	18	20	22	[5] 18	[5] 20
Public streets, alleys or roads in urban or rural districts	[6][13] 18	18	20	22	[5] 18	[5] 20
Driveways to residence garages	10	10	20	22	[5] 18	[5] 20
Spaces or ways accessible to pedestrians only	[7] 15	[8] 15	15	17	[9] 16	[9] 18
WHERE WIRES RUN ALONG, AND WITHIN THE LIMITS OF PUBLIC HIGHWAYS OR OTHER PUBLIC RIGHTS-OF-WAY FOR TRAFFIC						
Streets or alleys in urban districts	[10][11][13] 18	[10] 18	20	22	[5] 18	[5] 20
Roads in rural districts	[10][11][12] 14	[10] 15	18	20	[5] 18	[5] 20

Footnotes on following page.

232. A. Basic Clearances—Continued.

---

[1] Where subways, tunnels, or bridges require it, less clearances above ground or rails than required by table 1 may be used locally. The trolley contact conductor should be graded very gradually from the regular construction down to the reduced elevation.

[2] For wire crossings over railways handling only cars considerably lower than ordinary freight cars, the clearance may be reduced by an amount equal to the difference in height between the highest car handled and the highest ordinary freight car, but the clearance shall not be reduced below that required for street crossings.

[3] This clearance may be reduced to 25 feet where paralleled by trolley contact conductor on the same street or highway.

[4] In communities where 21 feet has been established, this clearance may be continued if carefully maintained. The elevation of the contact conductor should be the same in the crossing and next adjacent spans. (See rule 289, D, 2, for conditions which must be met where uniform height above rail is impracticable.)

[5] In communities where 16 feet has been established for trolley contact conductors 0 to 750 volts to ground, or 18 feet for trolley contact conductors exceeding 750 volts, or where local conditions make it impracticable to obtain the clearance given in the table, these reduced clearances may be used if carefully maintained.

[6] If a communication service drop, or a guy which is effectively insulated against the highest voltage to which it is exposed, up to 8,700 volts, crosses a street, alley or road, the clearance may be reduced to 16 feet at the side of the traveled way.

[7] This clearance may be reduced to the following values:

	Feet
(1) For communication conductors of circuits limited to 160 volts to ground, and communication cables	8
(2) For conductors of other communication circuits	10
(3) For guys	8

[8] This clearance may be reduced to the following values:

	Feet
(1) Supply wires (except trolley contact wires) limited to 300 volts to ground	12
(2) Supply wires (except trolley contact wires) limited to 150 volts to ground and located at entrances to buildings	10
(3) Where supply circuits of 550 volts or less, with transmitted power of 3,200 watts or less, are run along fenced (or otherwise guarded) private rights-of-way in accordance with the provisions specified in rule 220, B, 3	10

[9] Trolley contact conductors for industrial railways when not along or crossing over roadways may be placed at a less height if suitably guarded.

[10] Where a pole line along a road is located relative to fences, ditches, embankments, etc., so that the ground under the line will never be traveled except by pedestrians, this clearance may be reduced to the following values:

	Feet
(1) Communication conductors limited to 160 volts to ground, and communication cables	8
(2) Conductors of other communication circuits	10
(3) Supply conductors	12

[11] No clearance from ground is required for anchor guys not crossing streets, driveways, roads, or pathways, nor for anchor guys provided with traffic guards and paralleling sidewalk curbs.

[12] This clearance may be reduced to 13 feet for communication conductors where no part of the line overhangs any part of the highway which is ordinarily traveled, and where it is unlikely that loaded vehicles will be crossing under the line into a field.

[13] Where communication wires or cables cross over or run along alleys, this clearance may be reduced to 15 feet.

[14] A conductor which is effectively grounded throughout its length and is associated with a circuit of 750 to 15,000 volts between conductors may have the clearances specified for open supply wires of 0 to 750 volts.

[15] This value may be reduced to 25 feet for guys and for cables carried on messengers.

[16] Adjacent to overhead bridges which restrict the practice of permitting men on top of cars, these clearances may be reduced, within the restricted area, by mutual agreement between the parties at interest, but in no case shall the wires or cables be at levels below the undersurface of the bridge.

232. Vertical Clearance of Wires Above Ground or Rails—Continued.

B. Increased Clearances.

Greater clearances than specified in table 1 (rule 232, A) shall be provided where required by 1, 2, and 3 below. Increases are cumulative where more than one apply.

Exception: Increased clearances are not required for trolley contact conductors, for guys, or for cable supported by messenger.

1. SPANS LONGER THAN SPECIFIED IN RULE 232, A, 2. In applying the following rules, the "point of crossing" in the case of roads, streets, alleys and driveways is considered to be the edge of the traveled way farthest from the nearer support of the crossing span. In the case of a railroad crossing, it is the track rail which is farthest from the nearer support of the crossing span. In other situations it is the location under the conductors of any topographical feature which is the determinant of the clearance.

(a) WHERE POINT OF CROSSING OCCURS AT POINT OF MAXIMUM TOTAL SAG OF THE CONDUCTOR.

(1) GENERAL. For spans exceeding the limits specified in rule 232, A, 2, above, the clearance specified in table 1 shall be increased by 0.1 foot for each 10 feet of the excess of span length over such limits. See (3) below.

(2) RAILROAD CROSSINGS. For spans exceeding the limits specified in rule 232, A, 2, above, the clearance specified in table 1 shall be increased by the following amounts for each 10 feet by which the

232. B. Increased Clearances—Continued.

crossing span length exceeds such limits. See (3) below.

Loading district	Amount of increase per 10 feet	
	Large conductors	Small[1] conductors
	Feet	*Feet*
Heavy and medium	0. 15	0. 30
Light	. 10	. 15

[1] A small conductor is a conductor having an over-all diameter of metallic material equal to or less than the following values:

Material	Outside diameter of conductor	
	Solid	Stranded
	Inches	*Inches*
All copper	0. 160	0. 250
Other than all copper	. 250	. 275

(3) LIMITS. The maximum additional clearance need not exceed the following percentages of the "maximum sag increase" for the conductor concerned:

Loading district	Percentage
Heavy	75
Medium	85
Light	75

The "maximum sag increase" to which these percentages apply is the arithmetic difference between final unloaded sag at 60° F, no wind, and the maximum total sag under the entire conductor loading of rule 251 for the loading district con-

232. B. Increased Clearances—Continued.

cerned, or under 120° F, no wind, whichever sag is the greater, computed for the span length for which such difference is greatest.

(b) WHERE POINT OF CROSSING IS NOT AT POINT OF MAXIMUM TOTAL SAG OF THE CONDUCTOR.

Under these conditions the required clearance may be obtained by multiplying the clearance determined by rules 232, A and 232, B, 1 (a) by the following factors, but in no case shall the clearance be less than required by table 1:

Distance from nearer support of crossing span to point of crossing in percentage of crossing span length	Factors
5	0. 85
10	. 88
15	. 91
20	. 94
25	. 96
30	. 98
35	. 99
40 to 50	1. 00
Interpolate for intermediate values	

2. VOLTAGES EXCEEDING 50,000 VOLTS BETWEEN CONDUCTORS.

For these voltages the clearances given in table 1 (rule 232, A) shall be increased at the rate of 0.5 inch for each 1,000 volts of the excess.

3. CONDUCTORS SUPPORTED BY SUSPENSION-TYPE INSULATORS AT CROSSINGS OVER TRACK RAILS.

The clearance shall be increased by such an amount that the values specified in table 1

232. B. Increased Clearances—Continued.

(rule 232, A) will be maintained in case of a broken conductor in either adjoining span, if the conductor is supported as follows:

(a) At one support by suspension-type insulators in a suspended position, and at the other support by insulators which are not free to swing (including semistrain-type insulators).

(b) At one support by strain insulators, and at the other support by semistrain-type insulators.

4. METHODS OF AVOIDING THIS INCREASE OF CLEARANCE.

Any of the following construction methods will avoid the necessity for the increase in clearance required by rule 232, B, 3:

(a) *Suspension-type insulators* in a suspended position at both supports.

(b) *Semistrain-type insulators* at both supports.

(c) *Arrangement of insulators* so that they are restrained from displacement toward the crossing.

C. Supply Pole Wiring at Underground Risers.

Supply wires connecting to underground systems shall not be run open closer to the ground than is indicated by table 2:

TABLE 2.—*Clearance above ground for open supply wiring*

Location on pole	Voltage between conductors		
	0 to 750 volts	750 to 15,000 volts	More than 15,000 volts
	Feet	*Feet*	*Feet*
Side of pole adjacent to vehicular traffic	14	16	18
Side of pole not adjacent to vehicular traffic	8	11	13

233. WIRE-CROSSING CLEARANCES.

The clearance between any two wires crossing each other and carried on different supports shall be not less than the following:

A. Basic Clearances.

The clearances given in table 3 below apply under the following conditions:

1. Temperature of 60° F, no wind, with the upper conductor or wire at its final unloaded sag and the lower conductor or wire at its initial unloaded sag.
2. Span lengths not greater than the following for the upper conductor or wire:

Loading district	Span lengths
	Feet
Heavy	[1] 175
Medium	[1] 250
Light	350

[1] 150 feet in heavy loading district and 225 feet in medium loading district for 3-strand conductors, each wire of which is 0.09 inch or less in diameter.

3. Voltages 0 to 50,000 volts between conductors.
4. Fixed supports for the upper conductor or wire.

233. A. Basic Clearances—Continued.

Table 3.—*Wire-crossing clearances*

[All voltages are between wires except for trolley contact conductors where voltages are to ground]

[The insertion of a given clearance in italics indicates that in general the lines operating at the voltage named above this clearance should not cross over the lines at the voltage to the left of the clearance in italics]

Nature of wires crossed over	Communication wires, including cables and messengers	Open supply wires 0 to 750 volts; supply cables, all voltages, having effectively grounded continuous metal sheaths or messengers; messengers associated with such cables		Open supply wires and service drops [6]		Guys, span wires, lightning-protection wires
		Line wires	Service drops	750 to 8,700 volts	8,700 to 50,000 volts	
Communication, including cables and messengers	*Feet* [2] 2	*Feet* [9] [3] 4	*Feet* [9] 2	*Feet* [7] 4	*Feet* [10] 6	*Feet* [2] 2
Supply cables, all voltages, having effectively grounded continuous metal sheaths or messengers; messengers associated with such cables	*4*	2	2	2	4	2
Open supply wires:						
0 to 750 volts	*4*	2	2	2	4	2
750 to 8,700 volts	*4*	*2*	*4*	2	4	4
8,700 to 50,000 volts	*6*	*4*	*6*	*4*	4	4
Trolley contact conductors	[4] 4	[4] [5] 4	[4] 4	6	6	[4] 4
Guys, span wires, lightning-protection wires, service drops 0 to 750 volts	[2] [8] 2	2	2	4	4	[1] [2] 2

Footnotes on following page.

233. Wire-Crossing Clearances—Continued.

B. Increased Clearances.

Greater clearances than given in table 3 (rule 233, A) shall be provided under the following conditions. The increases in 1, 2, and 3 below are cumulative where more than one are applicable.

1. CROSSING SPANS LONGER THAN SPECIFIED IN RULE 233, A, 2.

Under these conditions the clearances specified in table 3 shall be increased as follows:

(a) Where the crossing occurs at the point of maximum total sag in the upper conductor, the clearances of table 3 shall be increased by the following amounts for each 10 feet by which the crossing span

---

[1] Completely insulated sections of guys attached to supporting structures having no conductor of more than 8,700 volts may have less than this clearance from each other.

[2] The clearance of communication conductors and their guy, span, and messenger wires from each other in locations where no other classes of conductors are involved may be reduced by mutual consent of the parties concerned, subject to the approval of the regulatory body having jurisdiction, except for fire-alarm wires and wires used in the operation of railroads, or where one set of conductors is for public use and the other used in the operation of supply systems.

[3] Except where neutral conductors of primary supply circuits are concerned, a clearance of 2 feet may be permitted where the supply conductor is above the communication conductor, provided the crossing is not within 6 feet of any pole concerned in the crossing and the voltage to ground does not exceed 300 volts. (See note 9.)

[4] Trolley-contact conductors of more than 750 volts should have at least 6 feet clearance. This clearance should also be provided over lower-voltage trolley-contact conductors unless the crossover conductors are beyond reach of a trolley pole leaving the trolley-contact conductor or are suitably protected against damage from trolley poles leaving the trolley-contact conductor.

[5] Trolley feeders are exempt from this clearance requirement for trolley-contact conductors if they are of the same nominal voltage and of the same system.

[6] A conductor which is effectively grounded throughout its length and is associated with a circuit of 750 to 15,000 volts between conductors may have the clearances specified for open supply wires of 0 to 750 volts.

[7] This clearance shall be increased to 6 feet where the supply wires cross over a communication line within 6 feet horizontally of a communication pole.

[8] This clearance shall be increased to 4 feet where communication cables cross over open supply service wires.

[9] Where a 2-foot clearance is required at 60° F, and where conditions are such that the sag in the upper conductor would increase more than 1.5 feet at the crossing point under the applicable loading of rule 251, the 2-foot clearance shall be increased by the amount of sag increase less 1.5 feet.

[10] Multigrounded wye circuits not exceeding 8,700 volts to ground may have a 4-foot clearance if the lowest supply wire at the crossing under conditions of 60° F, no wind, and final unloaded sag is not lower than a straight line joining the points of support of the highest communication conductor, provided it is not within 6 feet horizontally of a communication pole.

233. B. Increased Clearances—Continued.

length exceeds the limits specified in rule 233, A, 2:

Loading district	Amount of increase per 10 feet	
	Large conductors	Small conductors[1]
	Feet	*Feet*
Heavy and medium	0. 15	0. 30
Light	. 10	. 15

[1] A small conductor is a conductor having an over-all diameter of metallic material equal to or less than the following values:

Material	Outside diameter of conductor	
	Solid	Stranded
	Inches	*Inches*
All copper	0. 160	0. 250
Other than all copper	. 250	. 275

The maximum additional clearance need not exceed the following percentages of the "maximum sag increase" for the conductor concerned:

Loading district	Percentage
Heavy	75
Medium	85
Light	75

The "maximum sag increase" to which these percentages apply is the arithmetic difference between final unloaded sag at 60° F, no wind, and the maximum total sag under the entire conductor loading of

233. B. Increased Clearances—Continued.

rule 251 for the loading district concerned, or under 120° F, no wind, whichever sag is the greater, computed for the span length for which such difference is greatest.

(b) If the crossing point is located elsewhere than at the point of maximum total sag in the upper span, the required clearance may be obtained by multiplying the clearance determined in rule 233, A and B, 1 (a) by the following factors, but in no case shall the clearance be less than required by table 3:

Distance from nearer support of crossing span to point of crossing, in percentage of crossing span length	Factors for basic clearance of—	
	4 feet	6 feet
5	0. 35	0. 47
10	. 47	. 58
15	. 60	. 68
20	. 71	. 78
25	. 82	. 85
30	. 90	. 92
35	. 96	. 98
40 to 50	1. 00	1. 00

Interpolate for intermediate values.

2. VOLTAGES EXCEEDING 50,000 VOLTS BETWEEN CONDUCTORS.

For these voltages the clearances given in table 3 (rule 233, A) shall be increased at the rate of 0.5 inch for each 1,000 volts of the excess.

3. CONDUCTORS SUPPORTED BY SUSPENSION-TYPE INSULATORS AT CROSSINGS OVER COMMUNICATION WIRES.

For such conductors the clearance shall be increased by such an amount that the values

233. B. Increased Clearances—Continued.

specified in table 3 (rule 233, A) will be maintained in case of a broken conductor in either adjacent span, provided such conductor is supported as follows:

(a) At one support by suspension-type insulators in a suspended position, and at the other support by insulators not free to swing (including semistrain-type insulators).
(b) At one support by a strain insulator, and at the other support by a semistrain-type insulator.

4. METHODS OF AVOIDING THIS INCREASE OF CLEARANCE.

Any of the following construction methods will avoid the necessity for the increase in clearance required by rule 233, B, 3:

(a) *Suspension-type insulators* in a suspended position at both supports.
(b) *Semistrain-type insulators* at both supports.
(c) *Arrangement of insulators* so that they are restrained from displacement toward the crossing.

234. CLEARANCES OF CONDUCTORS OF ONE LINE FROM OTHER CONDUCTORS AND STRUCTURES.

A. Clearances from Conductors of Another Line.

The clearance in any direction between any conductor of one line and any conductor of a second and conflicting line shall be not less than the largest value required by 1, 2, or 3 below at 60° F, no wind:

1. Four feet.
2. The values required by rule 235, A, 2, (a) (1), or (2) for separation between conductors on the same support.
3. The apparent sag of the conductor having the greater sag, plus 0.2 inch per kilovolt of the highest voltage concerned.

234. A. Clearances from Conductors of Another Line—Continued.

Exception: In situations where supply-line conductors only are involved, the clearance required by 3 above need not be greater than the value required by rule 233, A and B, for a center-span crossing, assuming the conductor having the larger sag swinging through an arc of 45° from the vertical.

B. Clearances from Supporting Structures of Another Line.

Conductors of any line passing near a pole or similar supporting structure of a second line, without being attached thereto, shall have clearances from any part of such structure not less than the larger value required by either 1 or 2 below at 60° F, no wind:

1. Three feet if practicable.
2. The values required by rule 235, A, 2, (a) (1) and (2) for separation between similar conductors on the same support, increased by 1 inch for each 2 feet of the distance from the supporting structure of the second line to the nearest supporting structure of the first line.

The climbing space on the structure of the second line shall in no case be reduced by a conductor of the first line.

C. Clearances from Buildings.

1. GENERAL.

Conductors shall be arranged and maintained so as to hamper and endanger firemen as little as possible in the performance of their duties.

2. LADDER SPACE.

Where buildings exceed three stories (or 50 feet) in height, overhead lines should be arranged where practicable so that a clear space or zone at least 6 feet wide will be left, either adjacent to the building or beginning not over 8 feet from

234. C. Clearances from Buildings—Continued.

the building, to facilitate the raising of ladders where necessary for fire fighting.

Exception: This requirement does not apply where it is the unvarying rule of the local fire departments to exclude the use of ladders in alleys or other restricted places which are generally occupied by supply lines.

3. OPEN SUPPLY CONDUCTORS ATTACHED TO BUILDINGS.

Where the permanent attachment of open supply conductors of any class to buildings is necessary for an entrance, such conductors shall meet the following requirements:

(a) Conductors of more than 300 volts to ground shall not be carried along or near the surface of the building unless they are guarded or made inaccessible.

(b) Clearance of wires from building surface shall be not less than those required in table 9 (rule 235, A, 3, (a)) for clearance of conductors from pole surfaces.

4. CONDUCTORS PASSING BY OR OVER BUILDINGS.

(a) MINIMUM CLEARANCES. Unguarded or accessible supply conductors carrying voltages in excess of 300 volts between conductors shall not come closer to any building or its attachments (balconies, platforms, etc.) than listed below, except that this rule should not be interpreted as restricting the installation of a trolley contact conductor over the approximate center line of the track it serves.

(1) SPANS 0 TO 150 FEET. For spans of 0 to 150 feet, the clearances shall be as given in table 4.

234. C. Clearances from Buildings—Continued.

TABLE 4.—*Clearances of supply conductors from buildings*

[All voltages are between conductors]

Voltage of supply conductors	Horizontal clearance	Vertical clearance
	Feet	*Feet*
300 to 8,700	3	8
8,700 to 15,000	8	8
15,000 to 50,000	10	10
Exceeding 50,000	10 plus 0.5 inch per kv in excess.	10 plus 0.5 inch per kv in excess.

(2) SPANS EXCEEDING 150 FEET. Where span lengths exceed 150 feet, the increased clearances required by rule 232, B, 1 shall be provided.
Exception: These increased clearances are not required where the voltage of the supply conductors is from 300 to 8,700 volts between conductors.

(b) GUARDING OF SUPPLY CONDUCTORS. Supply conductors of 300 volts or more between conductors shall be properly guarded by grounded conduit, barriers, or otherwise, under the following conditions:

(1) Where the clearances set forth in table 4 (rule 234, C, 4, (a), (1)) cannot be obtained.

(2) Where such supply conductors are placed near enough to windows, verandas, fire escapes, or other ordinarily accessible places, to be exposed to contact by persons.

Note: Supply conductors in grounded metal-sheathed cable are considered to be guarded within the meaning of this rule.

234. Clearances of Conductors of One Line from Other Conductors and Structures—Continued.

D. Clearances from Bridges.

1. CLEARANCES OF CONDUCTORS FROM BRIDGES.

Supply conductors, not installed in grounded conduit or metal-sheath cable, which pass under, over, or near a bridge shall have clearances therefrom not less than given in table 5.

2. GUARDING TROLLEY-CONTACT CONDUCTORS LOCATED UNDER BRIDGES.

(a) WHERE GUARDING IS REQUIRED. Guarding is required where the trolley-contact conductor is located so that a trolley pole leaving the conductor can make simultaneous contact between it and the bridge structure.

TABLE 5.—*Clearances from bridges*

Voltages between conductors	Readily accessible portions (other than traveled ways[1]) of any bridge, including wing walls or bridge attachments		From ordinarily inaccessible portions[2] of bridges (other than brick, concrete, or masonry) and from abutments	
	For conductors attached to bridge[3]	For conductors not attached to bridge	For conductors attached to bridge[3 5]	For conductors not attached to bridge[4 5]
	Feet	*Feet*	*Feet*	*Feet*
0 to 2,500	3. 0	3. 0	0. 5	3. 0
Over 2,500 to 5,000	3. 0	3. 0	1. 0	3. 0
Over 5,000 to 8,700	3. 0	3. 0	3. 0	3. 0
Over 8,700 to 15,000	5. 0	5. 0	5. 0	5. 0
Over 15,000 to 25,000	7. 5	7. 5	7. 5	7. 5
Over 25,000 to 35,000	7. 5	9. 0	7. 5	9. 0
Over 35,000 to 50,000	7. 5	12. 0	7. 5	12. 0

---

[1] Where over traveled ways on or near bridges, the clearances of rule 232 apply.

[2] Bridge seats of steel bridges carried on masonry, brick, or concrete abutments which require frequent access for inspection shall be considered as readily accessible portions.

[3] Conductors should have clearance not less than given in this column, where practicable.

[4] Conductors should have the clearances given in this column increased as much as practicable.

[5] Where conductors passing under bridges are adequately guarded against contact by unauthorized persons and can be deenergized for maintenance of the bridge, clearances of the conductors from the bridge, at any point, may have the clearances specified in table 9 for clearance from surfaces of crossarms plus one-half the final unloaded sag of the conductor at that point.

234. D. Clearances from Bridges—Continued.

(b) NATURE OF GUARDING. Guarding shall consist of a substantial inverted trough of nonconducting material located above the contact conductor, or of other suitable means of preventing contact between the trolley pole and the bridge structure.

235. MINIMUM LINE-CONDUCTOR CLEARANCES AND SEPARATIONS AT SUPPORTS.

A. Separation Between Conductors on Pole Lines.

1. APPLICATION OF RULE.

(a) MULTICONDUCTOR WIRES OR CABLES. Cables, and duplex, triple or paired conductors supported on insulators or messengers, whether single or grouped, are for the purposes of this rule considered single conductors even though they may contain individual conductors not of the same phase or polarity.

(b) CONDUCTORS SUPPORTED BY MESSENGERS OR SPAN WIRES. Clearances between individual wires or cables supported by the same messenger, or between any group and its supporting messenger, or between a trolley feeder, supply conductor, or communication conductor, and their respective supporting span wires, are not subject to the provisions of this rule.

(c) MEASUREMENT OF CLEARANCES. The clearances and separations stated may be measured from the center of the supporting insulator instead of from the conductor itself.

2. HORIZONTAL SEPARATIONS BETWEEN LINE CONDUCTORS.

(a) FIXED SUPPORTS. Line conductors attached to fixed supports shall have horizontal separations from each other not less than the

235. A. Separation Between Conductors on Pole Lines—Continued.

larger value required by either (1) or (2) below for the situation concerned.

Exception 1: The pin spacing at buckarm construction may be reduced as specified in rule 236, F, to provide climbing space.

Exception 2: The pin spacing at bridge fixtures may be reduced as specified in rule 235, C.

Exception 3: Grades D and N need meet only the requirements of (1) below.

Exception 4: These clearances do not apply where conductors have insulating covering adequate for the voltage concerned.

(1) MINIMUM HORIZONTAL SEPARATION BETWEEN LINE CONDUCTORS OF THE SAME OR DIFFERENT CIRCUITS. Separations shall be not less than given in table 6.

TABLE 6.—*Minimum horizontal separation at supports between line conductors of the same or different circuits*

[All voltages are between conductors except for railway feeders, which are to ground]

Class of circuit	Separation	Notes
	Inches	
Communication conductors	6	Preferable minimum. Does not apply at conductor transposition points.
	3	Permitted where pin spacings less than 6 inches have been in regular use. Does not apply at conductor transposition points.
Railway feeders:		
0 to 750 volts, No. 4/0 or larger	6	
0 to 750 volts, smaller than No. 4/0	12	Where 10- to 12-inch separation has already been established by practice, it may be continued, subject to the provisions of rule 235, A, 2, (*a*), (2), for conductors having apparent sags not over 3 feet and for voltages not exceeding 8,700.
750 volts to 8,700 volts	12	
Other supply conductors:		
0 to 8,700 volts	12	
For all conductors of more than 8,700 volts add for each 1,000 volts in excess of 8,700 volts	0.4	

235. A. Separation Between Conductors on Pole Lines—Continued.

(2) SEPARATIONS ACCORDING TO SAGS. The separation at the supports of conductors of the same or different circuits of grades B, or C shall in no case be less than the values given by the following formulas, at 60° F, no wind. The requirements of rule 235, A, 2, (a), (1) apply if they give a greater separation than this rule.

For line conductors smaller than No. 2 AWG:

Separation $=0.3$ inch per kilovolt $+7\sqrt{(S/3)-8}$.

For line conductors of No. 2 AWG or larger:

Separation $=0.3$ inch per kilovolt $+8\sqrt{S/12}$.

S is the apparent sag in inches of the conductor having the greater sag, and the separation is in inches.

TABLE 7.—*Separation in inches required for line conductors smaller than No. 2 AWG*

Voltages between conductors	Sag (in inches)						
	36	48	72	96	120	180	240
2,400	14. 5	20. 5	28. 5	35. 0	40. 5	51. 5	60. 0
7,200	16. 0	22. 0	30. 0	36. 5	42. 0	52. 5	61. 5
13,200	18. 0	24. 0	32. 0	38. 5	43. 5	54. 5	63. 5
23,000	21. 0	27. 0	35. 0	41. 5	46. 5	57. 5	66. 5
34,500	24. 5	30. 5	38. 5	44. 5	50. 5	61. 0	70. 0
46,000	28. 0	34. 0	42. 0	48. 0	53. 5	64. 5	73. 0
69,000	--------	40. 5	48. 5	55. 0	60. 5	71. 0	80. 0

235. A. Separation Between Conductors on Pole Lines—Continued.

TABLE 8.—*Separation in inches required for line conductors No. 2 AWG or larger*

Voltages between conductors	Sag (in inches)						
	36	48	72	96	120	180	240
2,400	14.5	16.5	20.5	23.5	26.0	31.5	36.5
7,200	16.0	18.0	22.0	25.0	27.5	33.0	38.0
13,200	18.0	20.0	23.5	26.5	29.5	35.0	39.5
23,000	21.0	23.0	26.5	29.5	32.0	38.0	42.5
34,500	24.0	26.5	30.0	33.0	35.5	41.5	46.0
46,000	27.5	30.0	33.5	36.5	39.0	45.0	49.5
69,000	--------	36.5	40.5	43.5	46.0	51.5	56.5

(b) SUSPENSION INSULATORS NOT RESTRAINED FROM MOVEMENT. Where suspension insulators are used and are not restrained from movement, the conductor separation shall be increased so that one string of line insulators may swing transversely through an angle of 45° from a vertical position without reducing the values given in (a) above.

3. CLEARANCES IN ANY DIRECTION FROM LINE CONDUCTORS TO SUPPORTS, AND TO VERTICAL OR LATERAL CONDUCTORS, SPAN OR GUY WIRES, ATTACHED TO THE SAME SUPPORT.

(a) FIXED SUPPORTS. Clearances shall be not less than given in table 9.

235. A. Separation Between Conductors on Pole Lines—Continued.

TABLE 9.—*Minimum clearance in any direction from line conductors to supports, and to vertical or lateral conductors, span or guy wires attached to the same support*

[All voltages are between conductors]

Clearance of line conductors from—	Communication lines—		Supply lines		
	In general	On jointly used poles	0 to 8,700 volts		Exceeding 8,700 volts, add for each 1,000 volts of excess
			In general	On jointly used poles	
Vertical and lateral conductors:	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Of same circuit	3	3	3	3	0.25
Of other circuits	3	3	[6] 6	[6] 6	.4
Span and guy wires attached to same pole:					
General	[8] 3	[1] [8] 6	6	6	.4
When parallel to line	[8] 3	[1] [8] 6	[1] 12	[1] 12	.4
Lightning-protection wires parallel to line	([2] [5])	([2] [5])	([2] [5])	([2] [5])	.4
Surfaces of crossarms	[3] 3	[3] 3	3	3	.25
Surfaces of poles	[3] 3	[3] 5	[7] 3	[4] [7] 5	.25

[1] For guy wires, if practicable. For clearances between span wires and communication conductors, see rule 238, E, 3.

[2] Clearance shall not be less than the separation required by table 6 or rule 235, A, 2, (a), (2) between two line conductors of the voltage concerned.

[3] Communication conductors may be attached to supports on the sides or bottoms of crossarms or surfaces of poles with less clearances, if at least 40 inches from any supply line conductor of less than 8,700 volts and at least 60 inches from any supply line conductor of more than 8,700 volts carried on the same pole.

[4] This clearance applies only to supply conductors carried on crossarms below communication conductors, on joint poles. Where supply conductors are above communication conductors the clearance shall be at least 3 inches.

[5] For the purpose of applying the above table, the voltage of lightning-protection wires shall be considered as being the voltage to ground of the associated supply conductors.

[6] For supply circuits of 0 to 750 volts, this clearance may be reduced to 3 inches.

[7] A neutral conductor which is effectively grounded throughout its length and is associated with a circuit of 0 to 15,000 volts between conductors may be attached directly to the pole surface.

[8] Guys and messengers may be attached to the same strain plates or to the same throughbolts.

235. A. Separation Between Conductors on Pole Lines—Continued.

(b) Suspension Insulators not Restrained From Movement. Where suspension insulators are used and are not restrained from movement, the conductor clearances from surfaces of supports, from span or guy wires, or from vertical or lateral conductors shall be such that the values of clearances required by (a) above will be maintained with an insulator swing of 45° from the vertical position on steel or concrete supports, or 30° if on wood poles.

4. CONDUCTOR SEPARATION—VERTICAL RACKS.

Conductors or cables may be carried on vertical racks or separate brackets other than wood placed vertically at one side of the pole and securely attached thereto, if all the following conditions are met:

(a) The voltage between conductors shall be not more than 750 volts, except that cables having effectively grounded continuous metal sheath may carry any voltage.

(b) Conductors shall be of the same material or materials.

(c) Vertical spacing between conductors shall be not less than the following:

Span length	Vertical clearance between conductors
Feet	*Inches*
0 to 150	4
150 to 200	6
200 to 250	8
250 to 300	12

(See table 9, rule 235, A, 3, for necessary clearances from pole surfaces and rule 236, G, for method of providing climbing space.)

235. A. Separation Between Conductors on Pole Lines—Continued.

5. SEPARATION BETWEEN SUPPLY CIRCUITS OF DIFFERENT VOLTAGE CLASSIFICATIONS ON THE SAME CROSSARM.

Supply circuits of any one voltage classification as given in table 11 (rule 238, A, 1) may be maintained on the same crossarm with supply circuits of the next consecutive voltage classification only under the following conditions:

(*a*) If they occupy pin positions on opposite sides of the pole.

(*b*) If in bridge-arm or side-arm construction they are separated by a distance of not less than the climbing space required for the higher voltage concerned and provided for in rule 236.

(*c*) If the higher-voltage conductors occupy the outer pin positions and the lower-voltage conductors the inner pin positions.

(*d*) If series lighting or similar supply circuits are ordinarily dead during periods of work on or above the crossarm concerned.

(*e*) If the two circuits concerned are communication circuits used in the operation of supply lines, and supply circuits of less than 8,700 volts, and are owned by the same utility, provided they are installed as in (a) or (b) above.

B. Separation Between Conductors Attached to Buildings.

Separation of wires from each other shall be not less than those required in table 6 (rule 235, A, 2, (a) (1)) for separation of conductors from each other at supports.

Exception: Conductors on vertical racks or separate brackets other than wood placed vertically meeting the requirements of rule 235, A, 4 may have the separations specified in that rule.

235. Minimum Line-Conductor Clearances and Separations at Supports—Continued.

C. Separation Between Conductors Attached to Bridges.

Supply conductors attached to bridges and supported at frequent intervals may have less separation at supports than required by rule 235, A, 2, (*a*), (1) and (2). The separation shall be not less than the clearance between supply conductors and the surfaces of poles or crossarms required by rule 235, A, 3, (a), or less than the following:

Span length:	Separation *Inches*
0 to 20 feet	6
20 to 50 feet	9

236. CLIMBING SPACE.

A. Location and Dimensions.

1. A climbing space having the horizontal dimensions specified in rule 236, E, shall be provided past any conductors, crossarms, or other parts.
2. The climbing space need be provided on one side or corner of the pole only.
3. The climbing space shall extend vertically past any conductor or other part between levels above and below the conductor as specified in rule 236, E, F, G, and I, but may otherwise be shifted from any side or corner of the pole to any other side or corner.

B. Portions of Supporting Structures in Climbing Space.

Portions of the pole or structure when included in one side or corner of the climbing space are not considered to obstruct the climbing space.

C. Crossarm Location Relative to Climbing Space.

Recommendation: Crossarms should be located on the same side of the pole.

Exception: This recommendation does not apply where double crossarms are used on any pole or where crossarms on any pole are not all parallel.

236. Climbing Space—Continued.

D. Location of Supply Apparatus Relative to Climbing Space.

Transformers, regulators, lightning arresters, and switches when located below conductors or other attachments shall be mounted outside of the climbing space.

E. Climbing Space Through Conductors on Crossarms.

1. CONDUCTORS OF SAME VOLTAGE CLASSIFICATION ON SAME CROSSARM.

Climbing space between conductors shall be of the horizontal dimensions specified in table 10 (rule 236, E, 3), and shall be provided both along and across the line, and shall be projected vertically not less than 40 inches above and below the limiting conductors. Where communication conductors are above supply conductors of more than 8,700 volts, the climbing space shall be projected vertically at least 60 inches above the highest supply conductor.

Exception 1: This rule does not apply if it is the unvarying practice of the employers concerned to prohibit employees from ascending beyond the conductors of the given line, unless the line is killed.

Exception 2: For supply conductors carried on a pole in a position below communication facilities in the manner permitted in rule 220, B, 3, the climbing space need not extend more than 2 feet above such supply space.

2. CONDUCTORS OF DIFFERENT VOLTAGE CLASSIFICATIONS ON SAME CROSSARM.

The climbing space shall be that required by table 10 (rule 236, E, 3) for the highest voltage of any conductor bounding the climbing space. The climbing space shall extend vertically to the limits specified in rule 236, E, 1, and the exceptions thereto.

236. E. Climbing Space Through Conductors on Crossarms—Continued.

3. HORIZONTAL CLIMBING-SPACE DIMENSIONS.

Table 10.—*Minimum horizontal dimensions of climbing space*

Character of conductors adjacent to climbing space	Voltage of conductors		Horizontal dimensions of climbing space (inches)			
			On poles used solely by—		On jointly used poles	
	To ground	Between wires	Communication conductors	Supply conductors	Supply conductors above communication conductors	Communication conductors above supply conductors [1]
Communication conductors.	0 to 150		No requirement.		(2)	No requirement.
	Exceeding 150.		24 recommended.		(2)	24 recommended.
Supply conductors.	Less than 300.			24	24	30.
	300 to	8,700		30	30	30.
		8,700 to 15,000.		36	36	36.
		Exceeding 15,000.		More than 36.[3]	More than 36.[3]	More than 36.[3]

[1] This relation of levels is not, in general, desirable and should be avoided where practicable.

[2] Climbing space shall be the same as required for the supply conductors immediately above, with a maximum of 30 inches, except that a climbing space of 16 inches across the line may be employed for communication cables or conductors where the only supply conductors at a higher level are secondaries (0 to 750 volts between conductors) supplying airport or airway marker lights or crossing over the communication line and attached to the pole top or to a pole-top extension fixture.

[3] Where practicable. (Attention is called to the operating requirements of rule 422, part 4 of this code.)

F. Climbing Space on Buckarm Construction.

The full width of climbing space shall be maintained on buckarm construction and shall extend vertically in the same position at least 40 inches (or 60 inches where required by rule 236, E, 1) above and below any limiting conductor.

Method of Providing Climbing Space on Buckarm Construction. With circuits of less than 8,700 volts and span lengths not exceeding 150 feet and sags not exceeding 15 inches for wires of No. 2 and larger sizes, or 30 inches for wires smaller than No. 2, a six-pin cross-

236. F. Climbing Space on Buckarm Construction—Con.

arm having pin spacing of 14½ inches may be used to provide a 30-inch climbing space on one corner of a junction pole by omitting the pole pins on all arms, and inserting pins midway between the remaining pins so as to give a spacing of 7¼ inches, provided that each conductor on the end of every arm is tied to the same side of its insulator, and that the spacing on the next pole is not less than 14½ inches.

G. Climbing Space for Longitudinal Runs.

The full width of climbing space shall be provided past longitudinal runs and shall extend vertically in the same position from 40 inches below the run to a point 40 inches above (or 60 inches where required by rule 236, E, 1). The width of climbing space shall be measured from the longitudinal run concerned. Longitudinal runs on racks, or supply cables on messengers, are not considered as obstructing the climbing space if all wires concerned are covered by rubber protective equipment or otherwise guarded as an unvarying practice before workmen climb past them. This does not apply where communication conductors are above the longitudinal runs concerned.

Exception 1: If a supply longitudinal run is placed on the side or corner of the pole where climbing space is provided, the width of climbing space shall be measured horizontally from the center of the pole to the nearest supply conductors on crossarms, under the following conditions:

Where the longitudinal run consists of open supply conductors carrying not more than 750 volts between conductors or of effectively grounded continuous metal-sheathed supply cable carrying any voltage, and is supported close to the pole as by brackets, racks, or pins close to the pole, and

Where the nearest supply conductors on crossarms are parallel to and on the same side of

236. G. Climbing Space for Longitudinal Runs—Continued.

the pole as the longitudinal run and within 4 feet above or below the run.

Exception 2: For supply conductors carried on a pole in a position below communication facilities in the manner permitted in rule 220, B, 3, the climbing space need not extend more than 2 feet above such supply space.

H. Climbing Space Past Vertical Conductors.

Vertical runs incased in suitable conduit or other protective covering and securely attached to the surface of the pole or structure are not considered to obstruct the climbing space.

I. Climbing Space Near Ridge-Pin Conductors.

The climbing space specified in rule 236, E, 3 shall be provided above the top crossarm to the ridge-pin conductor but need not be carried past it.

237. WORKING SPACE.

A. Location of Working Spaces.

Working spaces shall be provided on the climbing face of the pole at each side of the climbing space.

B. Dimensions of Working Spaces.

1. ALONG THE CROSSARM.

The working space shall extend from the climbing space to the outmost pin position on the crossarm.

2. PERPENDICULAR TO THE CROSSARM.

The working space shall have the same dimension as the climbing space (see rule 236, E). This dimension shall be measured from the face of the crossarm.

3. VERTICALLY.

The working space shall have a height not less than that required by rule 238 for the vertical separation of line conductors carried at different levels on the same support.

237. Working Space—Continued.

C. Location of Vertical and Lateral Conductors Relative to Working Spaces.

The working spaces shall not be obstructed by vertical or lateral conductors. Such conductors shall be located on the opposite side of the pole from the climbing side or on the climbing side of the pole at a distance from the crossarms at least as great as the width of climbing space required for the highest-voltage conductors concerned. Vertical conductors inclosed in suitable conduit may be attached on the climbing side of the pole.

D. Location of Buckarms Relative to Working Spaces.

Buckarms may be used under any of the following conditions, provided the climbing space is maintained. Climbing space may be obtained as in rule 236, F.

1. STANDARD HEIGHT OF WORKING SPACE.

Lateral working space of the height required by table 11 (rule 238, A, 1) may be provided between the buckarms and adjacent line arms to which conductors on the buckarms are not attached.

Method of meeting requirements. This may be accomplished by increasing the spacing between the line crossarm gains.

2. REDUCED HEIGHT OF WORKING SPACE.

Where no circuits exceeding 8,700 volts between conductors are involved, and the clearances of rule 235, A, 2, (a), (1) and (2) are maintained, buckarms may be placed between line arms having normal spacing, even though such buckarms obstruct the normal working space; provided that a working space of not less than 18 inches in height is maintained either above or below each line arm and each buckarm.

237. D. Location of Buckarms Relative to Working Spaces—Continued.

Exception: The above working space may be reduced to 12 inches if both of the following conditions exist:

Not more than two sets of line arms and buckarms are involved.

Working conditions are rendered safe by providing rubber protective equipment or other suitable devices to insulate and cover line conductors and equipment which are not being worked upon.

238. VERTICAL SEPARATION BETWEEN LINE CONDUCTORS, CABLES, AND EQUIPMENT LOCATED AT DIFFERENT LEVELS ON THE SAME POLE OR STRUCTURE.

All line conductors, cables, or equipment located at different levels on the same pole or structure shall have the vertical separations set forth below.

A. Vertical Separation Between Horizontal Crossarms.

Crossarms supporting line conductors shall be spaced in accordance with table 11. Vertical separations between crossarms shall be measured from center to center.

Exception: Where it is established practice to gain poles with lesser crossarm spacings than specified in table 11 such reduced crossarm separations may be employed if all other applicable separations are complied with.

1. BASIC SEPARATIONS.

The separations given in the following table are for crossarms carrying conductors of 0 to 50,000 volts between conductors attached to fixed supports.

238. A. Vertical Separation Between Horizontal Crossarms—Continued.

Table 11.—*Vertical separation of crossarms carrying conductors*

[All voltages are between conductors]

Conductors usually at lower levels	Supply conductors; preferably at higher levels				
	Open wires, 0 to 750 volts; cables, all voltages, having effectively grounded continuous metal sheath or messenger	750 to 8,700 volts	8,700 to 15,000 volts	15,000 to 50,000 volts	
				Same utility	Different utilities
	Feet	*Feet*	*Feet*	*Feet*	*Feet*
Communication conductors:					
General	[1,2] 4	4	6	------	6
Used in operation of supply lines	2	[3] 2	4	4	6
Supply conductors:					
0 to 750 volts	2	[4] 2	4	4	6
750 volts to 8,700 volts	--------	[4] 2	4	4	6
8,700 volts to 15,000 volts:					
If worked on alive with long-handled tools, and adjacent circuits are neither killed nor covered with shields or protectors	--------	------	4	4	6
If not worked on alive except when adjacent circuits (either above or below) are killed or covered by shields or protectors, or by the use of long-handled tools not requiring linemen to go between live wires	--------	------	2	[5] 4	[5] 4
Exceeding 15,000 volts, but not exceeding 50,000 volts	--------	------	------	[5] 4	[5] 4

Footnotes on following page.

238. A. Vertical Separation Between Horizontal Crossarms—Continued.

2. INCREASED SEPARATIONS FOR VOLTAGES EXCEEDING 50,000 VOLTS BETWEEN CONDUCTORS.

For voltages greater than 50,000 volts between conductors the clearances of table 11 shall be increased at the rate of 0.4 inch per 1,000 volts of the excess.

B. Vertical Separation Between Line Conductors on Horizontal Crossarms.

Where line conductors are supported on horizontal crossarms spaced as required in rule 238, A, the vertical separation between such conductors shall be not less than the following:

1. WHERE CONDUCTORS ON THE CROSSARM ARE OF THE SAME VOLTAGE CLASSIFICATION.

Under these conditions, the vertical separation required by table 11 may be reduced as follows:

Where crossarm separation required by table 11 is—	Separation between conductors may be reduced to—
2 feet	16 inches.
4 feet	40 inches.
6 feet	60 inches.

---

[1] Where supply circuits of 550 volts or less, with transmitted power of 3,200 watts or less, are run below communication circuits in accordance with rule 220, B, 3 the clearance may be reduced to 2 feet.

[2] In localities where the practice has been established of placing on jointly used poles, crossarms carrying supply circuits of less than 300 volts to ground and crossarms carrying communcation circuits at a vertical separation less than specified in the table, such existing construction may be continued until the said poles are replaced provided that—

The minimum separation between existing crossarms is not less than 2 feet, and that—
Extensions to the existing construction shall conform to the clearance requirements specified in table 11.

When communication conductors are all in cable, a supply crossarm carrying only wires of not more than 300 volts to ground may be placed at not less than 2 feet above the point of attachment of the cable to the pole provided that—

The nearest supply wire on such crossarm shall be at least 30 inches horizontally from the center of the pole, and that—
The cable be placed so as not otherwise to obstruct the climbing space.

[3] This shall be increased to 4 feet when the communication conductors are carried above supply conductors unless the communication-line-conductor size is that required for grade C supply lines.

[4] Where conductors are operated by different utilities, a minimum vertical spacing of 4 feet is recommended.

[5] These values do not apply to adjacent crossarms carrying phases of the same circuit or circuits.

238. B. Vertical Separation Between Line Conductors on Horizontal Crossarms—Continued.

2. WHERE CONDUCTORS OF DIFFERENT VOLTAGE CLASSIFICATIONS ARE ON SAME CROSSARM.

Under these conditions, the vertical separation between conductors on adjacent crossarms shall be that required by table 11 (rule 238 A, 1) above for the highest voltage classification concerned.

3. CONDUCTORS OF DIFFERENT SAGS ON SAME SUPPORT.

(a) VARIATION IN CLEARANCE. Line conductors supported at different levels on the same structure and strung to different sags shall have vertical spacings at the supporting structures so adjusted that the minimum spacing at any point in the span, at 60° F, no wind, shall not be reduced more than 25 percent from that required at the supports by rule 235, A, 2, (a), (1) and (2) and this rule.

(b) READJUSTMENT OF SAGS. Sags should be readjusted when necessary to accomplish the foregoing, but not reduced sufficiently to conflict with the requirements of rule 261, F, 4. In cases where conductors of different sizes are strung to the same sag for the sake of appearance or to maintain unreduced clearance throughout storms, the chosen sag should be such as will keep the smallest conductor involved in compliance with the sag requirements of rule 261, F, 4.

C. Separation in Any Direction.

The separation in any direction between conductors of the same or different voltage classification when carried on the same structure, but on crossarms which are not horizontal, shall be not less than the values given in table 11 (rule 238, A, 1 and 2) for vertical separation.

238. C. Separation in Any Direction—Continued.

The separation in any direction shall not in any case be less than the horizontal separation specified in rule 235, A, 2, (a), (1) and (2).

D. Vertical Separation for Line Conductors Not Carried on Crossarms.

The vertical separation between conductors not carried on crossarms shall be the same as required in rule 238, B, 1 for conductors on crossarms.

Exception: Conductors on vertical racks or separate brackets other than wood placed vertically meeting the requirements of rule 235, A, 4 may have separations as specified in that rule.

E. Vertical Separation Between Conductors and Non-Current-Carrying Metal Parts of Equipment.

1. EQUIPMENT.

For the purpose of measuring separations under this rule, "equipment" shall be taken to mean noncurrent-carrying metal parts of equipment, including metal supports for cables or conductors, and metal supply-crossarm braces which are attached to metal crossarms or are less than 1 inch from transformer cases or hangers which are not effectively grounded.

2. SEPARATIONS IN GENERAL.

Vertical separations between supply conductors and communication equipment, between communication conductors and supply equipment, and between supply and communication equipment shall be as follows, except as provided in 3, below:

Supply voltage between conductors	Vertical separation
	Inches
0 to 8,700	40
Exceeding 8,700	[a] 60

[a] Transformer cases and associated hangers and supply cables, when effectively grounded, may have a separation of 40 inches.

238. E. Vertical Separation Between Conductors and Non-Current-Carrying Metal Parts of Equipment—Continued.

3. SEPARATIONS FOR SPAN WIRES AND BRACKETS.

Span wires or brackets for lamps or trolley contact conductors shall have at least the vertical separations from communication equipment set forth below:

From open communication conductors on cross-arms:	
Span wire or bracket above cross-arm	20 inches.[1]
Span wire or bracket below cross-arm	2 feet.
From messenger wires carrying communication cables	1 foot.
From terminal box of communication cables, if practicable	1 foot.[2]
From communication brackets, bridle wire rings, or drive hooks	2 inches

[1] This may be reduced to 12 inches for either span wires or metal parts of lamp brackets at points 40 inches or more from the pole surface.

[2] Where it is not practicable to obtain a clearance of 1 foot from terminal boxes of communication cables, all metal parts of terminals shall have the greatest practicable separation from fixtures or span wires, including all supporting screws and bolts of both attachments.

Exception: If lamp brackets are effectively grounded, these separations do not apply.

239. CLEARANCES OF VERTICAL AND LATERAL CONDUCTORS FROM OTHER WIRES AND SURFACES ON THE SAME SUPPORT.

Vertical and lateral conductors shall have the clearances and separations required by this rule from other conductors, wires, or surfaces on the same support.

Exception 1: This rule does not prohibit the placing of supply circuits of the same or next voltage classification in the same iron pipe, if each circuit or set of wires be inclosed in a metal sheath.

Exception 2: This rule does not prohibit the placing of paired communication conductors in rings attached directly to the pole or to messenger.

239. Clearances of Vertical and Lateral Conductors From Other Wires and Surfaces on the Same Support—Continued.

Exception 3: This rule does not prohibit placing grounding conductors, neutral conductors which are effectively grounded throughout their length and associated with supply circuits of 0 to 15,000 volts, metal sheathed supply cables or conductors enclosed in conduit, directly on the pole.

Exception 4: This rule does not prohibit placing supply circuits of 550 volts or less and not exceeding 3,200 watts and properly insulated, in the same cable with control circuits with which they are associated.

A. Location of Vertical or Lateral Conductors Relative to Climbing Spaces, Working Spaces, and Pole Steps.

Vertical or lateral conductors shall be located so that they do not obstruct climbing spaces, or lateral working spaces between line conductors at different levels, or interfere with the safe use of existing pole steps.

Exception 1: This rule does not apply to portions of the pole which workmen do not ascend while the conductors in question are alive.

Exception 2: This rule does not apply to vertical runs incased in suitable conduit or other protective covering. (See rule 236, H.)

B. Conductors not in Conduit.

Conductors not incased in conduit shall have the same clearances from conduits as from other surfaces of structures.

C. Mechanical Protection near Ground.

Where within 8 feet of the ground, all vertical conductors, cables, and grounding wires shall be protected by a covering which gives suitable mechanical protection. For grounding wires from light-

239. C. Mechanical Protection near Ground—Continued.
ning arresters, the protective covering specified above shall be of wood molding, or other insulating material giving equivalent protection.

Exception 1: This covering may be omitted from armored cables or cables installed in a grounded metal conduit.

Exception 2: This covering may be omitted from lead-sheathed cables in rural districts.

Exception 3: This covering may be omitted from vertical runs of communication cables or conductors.

Exception 4: This covering may be omitted from grounding wires in rural districts having triple-braid weather-proof covering, or where such grounding wire is one of a number of grounding wires used to provide multiple grounds.

Exception 5: This covering may be omitted from wires which are used solely to protect poles from lightning.

D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles or Within Supply Space on Jointly Used Poles.

1. GENERAL CLEARANCES.

In general, clearances shall be not less than the values specified in table 12.

239. D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles, etc.—Continued.

TABLE 12.—*General clearances*

[All voltages are between conductors]

Clearance of vertical and lateral conductors	Clearances for highest voltage concerned in the clearance	
	0 to 8,700 volts	Exceeding 8,700 volts, add the following for each 1,000 in excess
	Inches	*Inches*
From surfaces of supports	3	0.25
From span, guy, or messenger wires	6	.4
From line conductors rigidly supported on fixed supports, such conductors being of—		
Same circuit	3	.25
Different circuits	6	.4
From line conductors not rigidly supported on fixed supports	(1)	(1)

(1) The clearances shall be increased beyond the values given above from line conductors on fixed supports (See rule 235, A, 2, (b), and 3, (b)).

2. SPECIAL CASES.

The following requirements apply only to portions of a pole which workmen ascend while the conductors in question are alive:

(a) SIDE-ARM CONSTRUCTION. Vertical conductors in metal-sheathed cables and grounding wires may be run without insulating protection from supply line conductors on poles used only for supply lines and employing side-arm construction on the side of the pole opposite to the line conductors if climbing space is provided on the line-conductor side of the pole.

(b) ON INSULATORS. Vertical and lateral conductors of less than 8,700 volts between con-

239. D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles, etc.—Continued.

ductors if on poles used only for supply lines may be run in multiple-conductor cables having suitable substantial insulating covering, if such cable is held taut on standard insulators supported on pins or brackets and is arranged so that the cable is held at a distance of approximately 5 inches from the surface of the pole, and from any pole step.

(c) CONDUCTORS TO STREET LAMPS. On poles used only for supply lines, open wires may be run from the supply line arm directly to the head of a street lamp, provided the clearances of table 12 are obtained and the open wires are substantially supported at both ends.

(d) CONDUCTORS OF LESS THAN 300 VOLTS. Vertical or lateral secondary supply conductors of not more than 300 volts to ground may be run in multiple-conductor cable attached directly to the pole surface or to crossarms in such a manner as to avoid abrasion at the point of attachment. Each conductor of such cable which is not effectively grounded, or the entire cable assembly, shall have an insulating covering required for a conductor of at least 1,000 volts.

(e) OTHER CONDITIONS. If open wire conductors are within 4 feet of the pole, vertical conductors where within a zone of 4 feet above and below such line conductors of not more than 8,700 volts between conductors, or where within a zone 6 feet above and below such line conductors of more than 8,700 volts between conductors, shall be run in one of the following ways:

(1) So as to clear the pole center by not less than 15 inches if the vertical conduc-

239. D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles, etc.—Continued.

tors are of 8,700 volts or less between conductors, or 20 inches if more than 8,700 volts;

(2) Enclosed in insulating conduit, or in metal conduit or cable protected by an insulating covering;

(3) Conductors with triple-braid weatherproof or equivalent covering and covered by wood molding.

Methods (2) and (3) apply also to lateral runs and to grounding conductors, except that conductors for grounding lightning-protection wires are not required to be covered within 6 feet above or below circuits of 15,000 volts or more.

E. Requirements for Vertical and Lateral Communication Conductors on Communication Line Poles or Within the Communication Space on Jointly Used Poles.

1. CLEARANCES FROM WIRES.

The clearances and separations of vertical and lateral conductors from other conductors (except those in the same ring run) and from guy, span, or messenger wires shall be 3 inches.

2. CLEARANCES FROM POLE AND CROSSARM SURFACES.

Vertical and lateral insulated communication conductors may be attached directly to a pole or crossarm. They shall have a vertical clearance of at least 40 inches from any supply conductors (other than vertical runs or lamp leads) of 8,700 volts or less between conductors, or 60 inches if more than 8,700 volts between conductors.

Exception: These clearances do not apply where the supply circuits involved are those carried in the manner specified in rule 220, B, 3.

239. Clearances of Vertical and Lateral Conductors From Other Wires and Surfaces on the Same Support—Continued.

F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles.

Vertical supply conductors, including grounding wires, which pass through communication line space on jointly used poles shall be installed as follows:

1. METAL-SHEATHED SUPPLY CABLES.

Metal-sheathed supply cables shall be covered as follows:

(a) Extent of Covering. Covering shall extend from the lowest points of such cables up to 40 inches above the highest communication conductors.

(b) Nature of Covering. The covering shall consist of wood molding or other suitable insulating material at points higher than 8 feet above the ground.

Exception 1: Metal pipe may be used throughout, under the following conditions:

On poles where there are no trolley attachments and the metal pipe is effectively grounded, no insulating covering is required.

On poles where there are trolley attachments or where the metal pipe is not effectively grounded, the pipe shall be covered with wood molding or other suitable insulating material from a point six feet below the lowest communication wire or trolley attachment to a point 40 inches above the highest communication wire or trolley attachment.

Exception 2: No insulating covering is required over supply secondary multi-

239. F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles—Continued.

conductor cables attached directly to the pole surface in accordance with the requirements of rule 239, F, 2 (c).

Exception 3: Where there are no trolley attachments on the pole, no insulating covering is required over supply cables having effectively grounded lead sheath, or supply cables having effectively grounded metal sheath of other types where mutually agreed to by the parties concerned.

2. SUPPLY CONDUCTORS.

Supply conductors shall be installed in one of the following ways:

(a) IN CONDUIT. Conductors of all voltages may be inclosed in the same way and to the same extent as required in 1 above for metal-sheathed cables.

(b) ON PINS AND INSULATORS. Vertical and lateral conductors of street-lighting circuits and service leads of less than 750 volts to ground may be run on the street side of the pole in multiple-conductor cable having suitable substantial insulating covering if such cable is held taut on standard insulators supported on pins or brackets and arranged so that the cable shall be held at a distance of approximately 5 inches away from the surface of the pole or from any pole steps.

(c) INSTALLED ON THE POLE SURFACE. Secondary supply conductors of not more than 300 volts to ground may be run in multiple-conductor cables attached directly to the pole surface in such a manner as to avoid abrasion at the points of attachment. In

239. F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles—Continued.

the case of aerial services, the point where such cables leave the pole shall be at least 40 inches above the highest, or 40 inches below the lowest, communication attachment. Each conductor of such cable which is not effectively grounded shall be insulated for a potential of at least 1,000 volts.

(d) SUSPENDED FROM SUPPLY CROSSARM. Lamp leads of street lighting circuits may be run from supply crossarms directly to a street lamp bracket or luminaire under the following conditions:

(1) The vertical run shall consist of paired wires or multiple-conductor cable securely attached at both ends to suitable brackets and insulators.

(2) The vertical run shall be held taut at least 40 inches from the surface of the pole (through the communication space), at least 12 inches beyond the end of any communication crossarm by which it passes, and at least 6 inches from communication drop wires.

(3) Insulators attached to lamp brackets for supporting the vertical run shall be capable of meeting, in the position in which they are installed, the same flashover requirements as the luminaire insulators.

(4) Each conductor of the vertical run shall be No. 10 AWG or larger.

3. SUPPLY GROUNDING WIRES.

Supply grounding wires shall be covered with wood molding or other suitable insulating cover-

239. F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles—Continued.

ing to the extent required for metal-sheathed cables in 1 above.

Exception: If there are no trolley attachments on the pole, insulating covering is not required for a grounding conductor which is metallically connected to a conductor which forms part of an effective grounding system.

4. SEPARATION FROM THROUGH BOLTS.

Vertical runs of supply conductors shall be separated from the ends of through bolts associated with communication line equipment by one-eighth of the circumference of the pole where practicable, but in no case less than 2 inches.

G. Requirements for Vertical Communication Conductors Passing Through Supply Space on Jointly Used Poles.

All vertical runs of communication conductors passing through supply space shall be installed as follows:

1. METAL-SHEATHED COMMUNICATION CABLES.

Vertical runs of metal-sheath communication cables shall be covered with wood molding, or other suitable insulating material, where they pass trolley feeders or other supply-line conductors. This insulating covering shall extend from a point 40 inches above the highest trolley feeders, or other supply conductors, to a point 6 feet below the lowest trolley feeders or other supply conductors, but need not extend below the top of any mechanical protection which may be provided near the ground.

Exception: Communication cables may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in rule 220, B, 3, without insulating covering within the supply space.

239. G. Requirements for Vertical Communication Conductors Passing Through Supply Space on Jointly Used Poles—Continued.

2. COMMUNICATION CONDUCTORS.

Vertical runs of insulated communication conductors shall be covered with wood molding, or other suitable insulating material, to the extent required for metal-sheathed communication cables in 1 above, where such conductors pass trolley feeders or other supply conductors.

Exception: Communication conductors may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in rule 220, B, 3, without insulating covering within the supply space.

3. COMMUNICATION GROUNDING CONDUCTORS.

Vertical communication grounding conductors shall be covered with wood molding or other insulating material between points at least 6 feet below and 40 inches above any trolley feeders or other supply line conductors by which they pass.

Exception: Communication grounding conductors may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in rule 220, B, 3, without insulating covering within the supply space.

4. SEPARATION FROM THROUGH BOLTS.

Vertical runs of communication conductors shall be separated from the ends of through bolts associated with supply-line equipment by one-eighth of the circumference of the pole where practicable, but in no case less than 2 inches.

240. General.

For the purposes of section 26, "Strength requirements", and section 27, "Line insulators", conductors and their supporting structures are classified under the grades specified in this section on the basis of the relative hazard existing.

241. Application of Grades of Construction to Different Situations.

A. Supply Cables.

For the purposes of these rules, supply cables are divided into two classes as follows:

1. SPECIALLY INSTALLED CABLES.

In this class are included metal-sheathed supply cables installed in accordance with rule 261, G, 1.

Note: Such cables are sometimes permitted to have a lower grade of construction than open-wire supply conductors of the same voltage.

2. OTHER CABLES.

In this class are included all other supply cables.

Note: Such cables are required to have the same grade of construction as open-wire supply conductors of the same voltage.

B. Two or More Conditions.

In any case where two or more conditions affecting the grade of construction exist, the grade of construction used shall be the highest one required by any of the conditions.

C. Order of Grades.

For supply and communication conductors and supporting structures, the relative order of grades is B, C, and N, grade B being the highest. Where grades D and N are specified for communication lines, grade D is the higher.

Note: Grade D cannot be directly compared with grades B and C, but rule 241, D, 3, (c) provides for cases where these two conditions are present.

241. Application of Grades of Construction, etc.—Con.

D. At Crossings.

1. GRADE OF UPPER LINE.

Conductors and supporting structures of a line crossing over another line shall have the grade of construction specified in rules 241, D, 3; 242, and 243.

2. GRADE OF LOWER LINE.

Conductors and supporting structures of a line crossing under another line need only have the grades of construction which would be required if the line at the higher level were not there.

3. MULTIPLE CROSSINGS.

(*a*) WHERE A LINE CROSSES IN ONE SPAN OVER TWO OTHER LINES. The grade of construction of the uppermost line shall be not less than the highest grade which would be required of either one of the lower lines if it crossed the other lower line.

Example: If a 2,300-volt line crosses in the same span over a communication line and a direct-current trolley contact conductor of more than 750 volts, the 2,300-volt line is required to comply with grade B construction at the crossing.
This is a double crossing and introduces a greater hazard than where the upper supply line crosses the communication line only.

(*b*) WHERE ONE LINE CROSSES OVER A SPAN IN ANOTHER LINE, WHICH SPAN IS IN TURN INVOLVED IN A SECOND CROSSING. The grade of construction for the highest line shall be not less than that required for the next lower line.

Exception: This requirement does not apply when the two upper lines are of

241. D. At Crossings—Continued.

such a nature and have such circuit protection that the danger of causing a break in the lower of these two lines by mechanical or electrical contact is eliminated.

(c) WHERE COMMUNICATION CONDUCTORS CROSS OVER SUPPLY CONDUCTORS AND RAILROAD TRACKS IN THE SAME SPAN. The grades of construction shall be in accordance with table 13.

Recommendation: It is recommended that the placing of communication conductors above supply conductors at crossings, conflicts, or on jointly used poles, be avoided unless the supply conductors are trolley contact conductors and their associated feeders.

TABLE 13.—*Grades of construction for communication conductors crossing over railroad tracks and supply lines*

When crossing over—	Communication conductor grades
Railroad tracks and supply lines of 0 to 750 volts to ground, or specially installed supply cables of all voltages	D
Railroad tracks and supply lines exceeding 750 volts to ground	B

E. Conflicts.

1. HOW DETERMINED.

Where two lines are adjacent (except at crossing spans) the distance between them and the relative heights above ground of poles and of conductors on each line determine whether conflict exists, and, if so, whether the conflict is a structure conflict (see definition) or a conductor conflict (see definition), or both.

TABLE 14.—*Grades of construction for supply conductors alone, at crossings, at conflicts, or on same poles with other conductors*

[All voltages are between wires except as indicated. Corresponding voltages to grounded neutral of grounded circuits are shown in parentheses. In applying the table to two-wire grounded circuits use the "to neutral" voltage]

Supply Conductors at Higher Levels [a] / Conductors, Tracks and Right of Ways at Lower Levels		Constant-potential supply conductors other than direct current railway feeders													Constant current supply conductors				Direct current railway feeders				Communication conductors used exclusively in the operation of, and run as, supply lines	
		0 to 750 Volts. (0 to 750 volts to Neutral)		750 to 5000 Volts. (750 to 2900 Volts to Neutral)			5000 to 8700 Volts. (2900 to 5000 Volts to Neutral)				Exceeding 8700 Volts. (Exceeding 5000 Volts to Neutral)				0 to 7.5 Amperes		Exceeding 7.5 Amperes		0 to 750 Volts		Exceeding 750 Volts			
		Urban	Rural	Urban		Rural	Urban		Rural		Urban		Rural											
		Open or Cable	Open or Cable	Open	Cable	Open or Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable
Fenced right of ways		N	N	ᵇN	N	N	ᵇN	N	N	N	ᵇN	ᵇN	N	N	B, C or N See Rule 242-A				B, C or N See Rule 242-B				C or N See Rule 242-C	
Elsewhere than on fenced right of ways		N	N	C	N	N	C	N	N	N	ᵉB	C	N	N										
Railroad tracks - Main or Minor		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Street-railway tracks having no overhead contact conductor		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Constant-potential supply conductors: 0-750 Volts. (0-750 Volts to Neutral)	Open or Cable	N	N	C	N	N	C	N	N	N	ᵉB	C	ᵈC	N	B, C or N See Rule 242-A				B, C or N See Rule 242-B				B, C or N See Rule 242-C	
Constant-potential supply conductors: 750-5000 Volts. (750 to 2900 Volts to Neutral)	Open	ᶜC	N	C	C	N	C	C	N	N	ᶜB	C	N	N										
	Cable	N	N	C	N	N	C	N	N	N	ᶜB	C	N	N										
Constant-potential supply conductors: 5000 to 8700 Volts (2900 to 5000 Volts to Neutral)	Open	ᵉC	N	C	C	N	C	C	N	N	ᶜB	C	N	N										
	Cable	N	N	C	N	N	C	N	N	N	ᶜB	C	N	N										
Constant-potential supply conductors: Exceeding 8700 Volts (Exceeding 5000 Volts to Neutral)	Open	ᵉB	ᵉC	N	N	N	B	B	N	N	ᵉB	C	N	N										
	Cable	ᵉC	N	C	N	N	C	N	N	N	ᶜB	C	N	N										
Constant current supply conductors - open or cable		B, C or N See Rule 242-A													B, C or N See Rule 242-A				B, C or N See Rules 242-A & B				B, C or N See Rules 242-A & C	
Direct current railway feeders - open or cable		B, C or N See Rule 242-B													B, C or N See Rules 242-A & B				B, C or N See Rule 242-B				B, C or N See Rules 242-B & C	
Trolley contact conductors - alternating or direct current		B, C or N See Rule 242-B													B, C or N See Rules 242-A & B				B, C or N See Rule 242-B				B, C or N See Rules 242-B & C	
Communication conductors, open or cable, used exclusively in the operation of supply lines		B, C or N See Rule 242-C													B, C or N See Rules 242-A & C				B, C or N See Rules 242-B & C				B, C or N See Rule 242-C	
Communication conductors - urban or rural, open or cable	Major[f]	N	N	C	C	C	ᵍB	ʰC	ᵍB	ʰC	ᵍB	ʰC	ᵍB	ʰC	C	C or N see Rule 242-A	ᵍ,ⁱB	C or N see Rule 242-A	N	N	ᵍB	ʰC	B, C or N See Rule 242-C	
	Minor[f]	N	N	C	C	C	C	C	C	C	C	C	C	C	C		C		N	N	C	C		

a. The words "open" and "cable" appearing in the headings have the following meanings as applied to supply conductors: "Cable" means the specially installed cables described in rule 241, A, 1. "Open" means open wire and also supply cables not "specially installed."

b. Where lines are located so that they can fall outside the fenced right of way into urban districts, the construction shall comply with the grades specified for lines not on fenced right of ways for corresponding voltages.

c. If circumstances within a given area warrant it, supply conductors need only meet the requirements of grade C construction if the supply circuits are so constructed, operated, and maintained that such circuits will be promptly deenergized, both initially and following subsequent breaker operations, in the event of a contact with lower supply conductors or other grounded objects.

d. Grade N construction may be used, if crossing over or conflicting with, supply services only.

e. If the wires are service drops, they may have grade N sizes and sags as set forth in tables 28 and 29 (rule 263, E).

f. Grade N construction may be used where the communication conductors consist only of not more than 1 insulated twisted-pair or parallel-lay conductor, or where 2 or more such insulated conductors are involved and these consist of service drops not grouped together in a single run.

g. The supply conductors need only meet the requirements of grade C construction if both of the following conditions are fulfilled:

(1) The supply and communication circuits are so constructed, operated and maintained that the supply circuits will be promptly deenergized, both initially and following subsequent breaker operations, in the event of a contact with the communication plant.

(2) The voltage and current impressed on the communication plant in the event of a contact with the supply conductors are not in excess of the safe operating limit of the communication protective devices.

h. Grade C construction applies to any supply cable on jointly used poles if carried above communication attachments and supported on an effectively grounded messenger.

i. Grade C construction may be used if the open-circuit voltage of the transformer supplying the circuit does not exceed 2,000 volts.

This table is to accompany National Bureau of Standards Handbook H32. Table revised June 1943.

1

2

2

242. Grades of Construction for Conductors—Continued.

C. Status of Communication Circuits Used Exclusively in the Operation of Supply Lines.

In determining grades of construction where communication circuits used exclusively in the operation of supply lines are concerned, they shall be considered as ordinary communication circuits when run as such (see rule 288, A, 3) and as supply circuits when run as such (see rule 288, A, 4).

Exception: Communication circuits located below supply circuits with which they are used shall not require such supply circuits to meet any rules for grade of construction other than that the sizes of such supply conductors shall be not less than required for grade C (see rule 261, F, 2).

D. Status of Fire-Alarm Conductors.

In determining grades of construction where fire-alarm conductors are concerned, they shall be considered as other communication circuits.

Exception: Fire-alarm conductors shall always meet grade D where the span length is from 0 to 150 feet, and grade C where the span length exceeds 150 feet.

E. Status of Neutral Conductors of Supply Circuits.

Supply-circuit neutral conductors, which are effectively grounded throughout their length and are not located above supply conductors of more than 750 volts to ground, shall have the same grade of construction as supply conductors of not more than 750 volts to ground, except that they need not meet any insulation requirements. Other neutral conductors shall have the same grade of construction as the phase conductors of the supply circuits with which they are associated.

242. E. Status of Neutral Conductors of Supply Circuits—Continued.

Table 15.—*Grades of construction for communication conductors alone, or in upper position at crossings, at conflicts, or on joint poles*

[All voltages are to ground, which, for ungrounded circuits, means the highest voltage between any two conductors.]

Communication conductors at higher levels[1] → Conductors, tracks, and rights-of-way at lower levels ↓			Communication conductors, rural or urban, open or cable, including communication conductors run as such, but used exclusively in the operation of supply lines	
			Major	Minor
Fenced rights-of-way			N	N
Elsewhere than on fenced rights-of-way			N	N
Railroad tracks—main or minor			D	D
Street-railway tracks having no overhead-contact wire			N	N
Constant-potential supply conductors[2]	0 to 750 volts	Open or cable	N	N
	750 to 2,900 volts	do	C	C
	Exceeding 2,900 volts	Open	B	C
		Cable	C	C
Constant-current supply conductors.[2]	0 to 7.5 amperes	Open[3]	C	C
	Exceeding 7.5 amperes	do.[3]	[4] B	C
Direct-current railway feeders.[2]	0 to 750 volts	Open or cable	N	N
	Exceeding 750 volts	do	B	C
Trolley-contact conductors.	0 to 750 volts	ac or dc	C	C
	Exceeding 750 volts	ac	[5] B or C	[5] B or C
		dc	B	C
Communication conductors, open or cable, used exclusively in the operation of supply lines			B, C, or N[6]	
Communication conductors, open or cable, urban or rural, major or minor			N	

---

[1] It is recommended that the placing of communication conductors above supply conductors at crossings, conflicts, or on jointly used poles be avoided, unless the supply conductors are trolley-contact conductors and their associated feeders.

[2] The words "open" and "cable" appearing in the headings have the following meaning as applied to supply conductors: "Cable" means the specially installed cables described in rule 241, A, 1. "Open" means open wire and also supply cables not specially installed.

[3] Where constant-current circuits are in specially installed cable, they are considered on the basis of the nominal full-load voltage.

[4] Grade C construction may be used if the open-circuit voltage of the transformer supplying the circuit does not exceed 2,900 volts.

[5] See rule 242, B.

[6] See rule 242, C.

243. GRADES OF SUPPORTING STRUCTURES.

A. Poles or Towers.

The grade of construction shall be that required for the highest grade of conductors supported.

Exception 1: The grade of construction of jointly used poles, or poles used only by communication lines, need not be increased merely because of the fact that communication wires carried on such poles cross over trolley contact conductors of 0 to 750 volts to ground.

Exception 2: Poles carrying grade C or D fire-alarm conductors, where alone, or where concerned only with other communication conductors, need meet only the requirements of grade N.

Exception 3: Poles carrying supply service loops of 0 to 750 volts to ground shall have at least the grade of construction required for supply line conductors of the same voltage.

Exception 4: Where communication lines cross over supply conductors and a railroad in the same span and grade B is required by rule 241, D, 3, (c) for the communication conductors, due to the presence of railroad tracks, the grade of the poles or towers shall be D.

Exception 5: At structure conflicts, even though no conductor conflict exists, the grade of construction which would be required by rule 242, if the conductors were in conflict, shall be applied to the pole or tower.

Note: This requirement may result in a higher grade of construction for the pole or tower than for the conductors carried thereon.

Exception 6: In the case where a structure conflict does not exist, but any conductor is in conductor conflict, the grade of construction of the pole or tower is not required to meet the conductor grade due to the conductor conflict.

243. Grades of Supporting Structures—Continued.

B. Crossarms.

The grade of construction shall be that required for the highest grade of conductors carried by the crossarm concerned.

Exception 1: The grade of construction of crossarms carrying only communication conductors need not be increased merely because of the fact that such conductors cross over trolley-contact conductors of 0 to 750 volts to ground.

Exception 2: Crossarms carrying grade C or D fire-alarm conductors, where alone or where concerned with other communication conductors, need meet only the requirements for grade N.

Exception 3: Crossarms carrying supply service loops of 0 to 750 volts to ground shall have at least the grade of construction required for supply line conductors of the same voltage.

Exception 4: Where communication lines cross over supply conductors and a railroad in the same span and grade B is required by rule 241, D, 3, (c) for the communication conductors due to the presence of railroad tracks, the grade of the crossarm shall be D.

C. Pins, Insulators, and Conductor Fastenings.

The grade of construction shall be that required for the conductor concerned.

Exception 1: The grade of construction of pins, insulators, and conductor fastenings carrying only communication conductors need not be increased merely because of the fact that such conductors cross over trolley-contact conductors of 0 to 750 volts to ground.

Exception 2: In the case of grade C or D fire-alarm conductors where alone, or where concerned only with other communication conductors, pins,

243. C. Pins, Insulators, and Conductor Fastenings—Con.

insulators, and conductor fastenings need meet only the requirements for grade N.

Exception 3: In the case of supply service loops of 0 to 750 volts to ground, pins, insulators, and conductor fastenings shall have at least the same grade of construction as required for supply-line conductors of the same voltage.

Exception 4: Where communication lines cross over supply conductors and a railroad in the same span, and grade B is required by rule 241, D, 3, (c) for the communication conductors due to the presence of railroad tracks, the grade of pins, insulators, and conductor fastenings shall be D.

Exception 5: In case communication conductors are required to meet grade B or C, the insulators need meet only the requirements for mechanical strength for these grades.

SEC. 25. LOADING FOR GRADES B, C, AND D

250. General Loading Map.

Three general degrees of loading due to weather conditions are recognized and are designated as heavy, medium, and light loading. The map in figure 1 shows the districts in the United States in which these loadings are normally applicable. It is recognized that loadings in certain areas in each of the loading districts are greater, and in some cases may be less, than those specified for the districts. It is expected that detailed districting will be carried out by state administrative authorities, which will delineate, as far as practicable, such areas. In the absence of such detailed districting, however, no reduction in the loadings specified in this code shall be made without approval of the administrative authority.

Note: The localities in the different groups are classed according to the relative prevalence of high wind velocity and thickness of ice which accumulates on wires, light loading being,

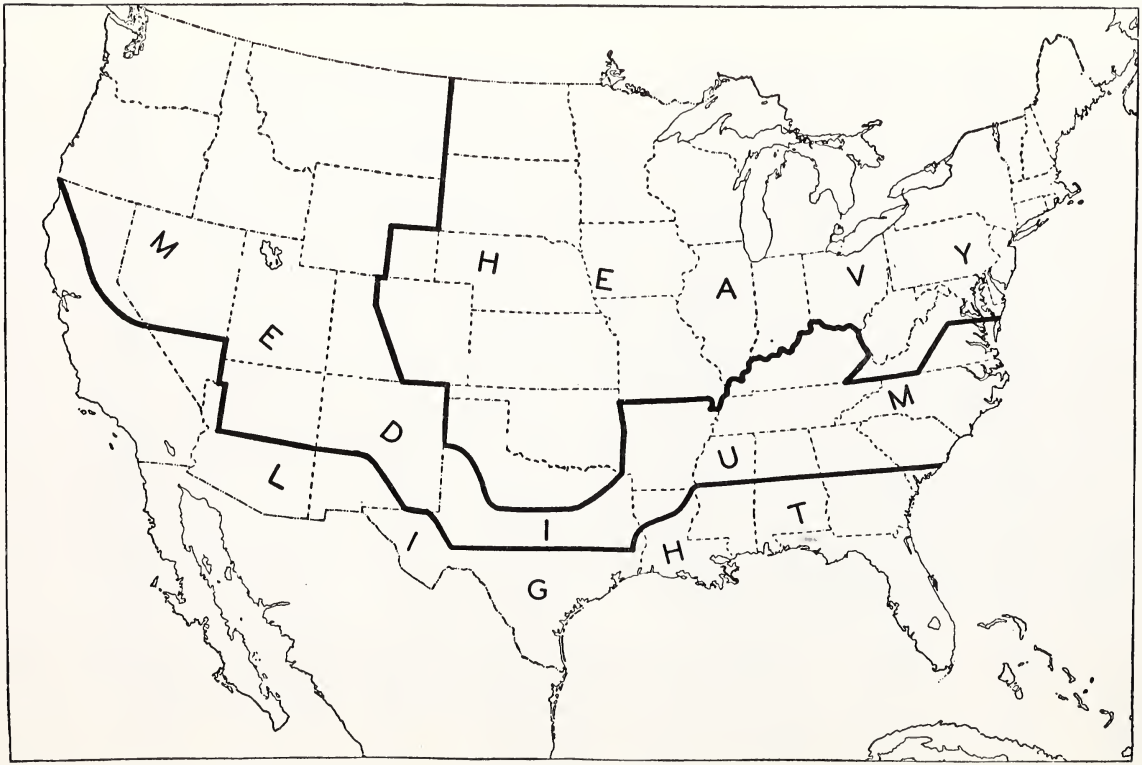

H
E
A
V
Y
M
E
D
I
U
M
L
I
G
H
T

FIGURE 1.—*General loading map showing territorial division of the United States with respect to loading of overhead lines.*

250. General Loading Map—Continued.

in general, for places where little, if any, ice ever accumulates on wires.

Where high wind velocities are frequent in a given place the loading for that place may be classed as heavy, even though ice does not accumulate to any greater extent than at some other place having less severe winds which has been classed as a medium loading district.

251. CONDUCTOR LOADING.

The loading on conductors shall be assumed to be the resultant loading per foot equivalent to the vertical load per foot of the conductor, ice-covered where specified, combined with the transverse loading per foot due to a transverse, horizontal wind pressure upon the projected area of the conductor, ice-covered where specified, to which equivalent resultant shall be added a constant. In the tabulation below are the values for ice, wind, temperature, and constants which shall be used to determine the conductor loading.

	Loading district		
	Heavy	Medium	Light
Radial thickness of ice (in.)	0. 50	0. 25	0
Horizontal wind pressure in pounds per square foot	4	4	9
Temperature (° F)	0	+15	+30
Constant to be added to the resultant in pounds per foot:			
For bare conductors of copper, steel, copper alloy, copper-covered steel, and combinations thereof	0. 29	0. 19	0. 05
For bare conductors of aluminum (with or without steel reinforcement)	. 31	. 22	. 05
For weather-proof and similar covered conductors (all materials)	. 31	. 22	. 05

251. Conductor Loading—Continued.

Note: Since heavy ice does not often form on conductors in a heavy wind, the transverse loading assumed is deemed sufficient for the purpose, but is not sufficient to represent the vertical (or combined) load which is imposed on conductors by the heavy deposits of ice which frequently form in comparatively still air. In order to apply a total loading to conductors representing more nearly the conditions encountered in practice, constants have been added to the conductor loading which make no substantial change in the conductor loading specified in the fourth edition of this code.

Where cables are concerned, the specified loadings shall be applied to both cable and messenger.

In applying loadings to bare stranded conductors, the coating of ice shall be considered as a hollow cylinder touching the outer strands.

252. LOADS UPON LINE SUPPORTS.

A. Assumed Vertical Loading.

The vertical loads upon poles, towers, foundations, crossarms, pins, insulators, and conductor fastenings shall be their own weight plus the superimposed weight which they support, including all wires and cables, ice-coated in heavy and medium loading districts, together with the effect of any difference in elevation of supports. The radial thickness of ice shall be computed only upon wires, cables, and messengers, and shall be taken as the following:

Heavy loading district (H), 0.50 inch of ice.
Medium loading district (M), 0.25 inch of ice.
Light loading district (L), no ice.

Ice is assumed to weigh 57 pounds per cubic foot.

Note: The weight of ice upon supports is ignored for the sake of simplicity.

B. Assumed Transverse Loading.

In computing the stresses in poles, towers, and side guys the loading shall be taken as one of the following according to climatic conditions of the locality concerned.

252. B. Assumed Transverse Loading—Continued.

1. HEAVY LOADING (H).

A horizontal wind pressure, at right angles to the direction of the line, of 4 pounds per square foot upon the projected area of cylindrical surfaces of all supported conductors and messengers, when covered with a layer of ice 0.5 inch in radial thickness and on surfaces of the poles and towers without ice covering, shall be called heavy loading. (See 4 and 5 following.)

For supporting structures carrying more than 10 wires, not including cables supported by messengers, where the pin spacing does not exceed 15 inches, the transverse load shall be calculated on two-thirds of the total number of such wires with a minimum of 10 wires.

2. MEDIUM LOADING (M).

A horizontal wind pressure at right angles to the direction of the line, of 4 pounds per square foot upon the projected area of cylindrical surfaces of all supported conductors and messengers when covered with a layer of ice 0.25 inch in radial thickness and on the surfaces of the poles and towers without ice covering, shall be called medium loading. (See 4 and 5 following.)

For supporting structures carrying more than 10 wires, not including cables supported by messengers, where the pin spacing does not exceed 15 inches, the transverse load shall be calculated on two-thirds of the total number of such wires with a minimum of 10 wires.

3. LIGHT LOADING (L).

A horizontal wind pressure at right angles to the direction of the line of 9 pounds per square foot upon the projected area of cylindrical surfaces of all supported conductors and messengers, poles and towers without ice covering, shall be called light loading. (See 4 and 5 following.)

252. B. Assumed Transverse Loading—Continued.

4. TROLLEY-CONTACT CONDUCTORS.

When a trolley-contact conductor is supported on a pole it shall be included in the computation of the transverse load on the structure.

5. FLAT SURFACES.

For flat surfaces the assumed unit wind pressure shall be increased by 60 percent. Where latticed structures are concerned, the actual exposed area of one lateral face shall be increased by 50 percent to allow for the pressure on the opposite face; this total, however, need not exceed the pressure which would occur on a solid structure of the same outside dimensions. The results obtained by more exact calculations may be substituted for the values obtained by this simple rule.

6. AT ANGLES (COMBINED LONGITUDINAL AND TRANSVERSE LOADING).

Where a change in direction of wires occurs, the loading upon the structure, including guys, shall be assumed to be a resultant load equal to the vector sum of the transverse wind load given in 1, 2, or 3 above and the resultant load imposed by the wires due to their change in direction. In obtaining these loadings, a wind direction shall be assumed which will give the maximum resultant load, proper reduction being made in loading to account for the reduced wind pressure on the wires resulting from the angularity of the application of the wind to the wires.

C. Assumed Longitudinal Loading.

1. CHANGE IN GRADE OF CONSTRUCTION.

The longitudinal loading upon supporting structures, including poles, towers, and guys at ends of sections required to be of grade B construction, when located in lines of lower than grade B construction, shall be taken as an unbalanced pull in

252. Assumed Longitudinal Loading—Continued.

the direction of the higher grade section equal to the pull of two-thirds of the conductors supported thereon which are smaller than No. 2 AWG, the conductor loading to be that given in rule 251, and such two-thirds of the conductors being selected so as to produce the maximum stress in the supports.

If the application of the above results in a fractional part of a conductor, the nearest whole number shall be used. In no case shall the assumed unbalanced pull on the supporting structure be less than the maximum loaded tension in any two of the conductors carried (including overhead ground wires), such two conductors being selected so as to produce the maximum stress in the supports.

2. JOINTLY USED POLES AT CROSSINGS OVER RAILROADS OR COMMUNICATION LINES.

Where a joint line crosses over a railroad or a communication line and grade B is required for the crossing span, the tension in the communication conductors of the joint line may be considered as limited to one-half their breaking strength, provided they are smaller than No. 8 Stl. WG, if of steel, or No. 6 AWG, if of copper, regardless of how small the initial sags of the communication conductors at 60° F.

3. DEAD-ENDS.

The longitudinal loading upon supporting structures shall be taken as an unbalanced pull equal to the tensions of all conductors and messengers (including overhead ground wires), under the conditions of conductor loading specified in rule 251.

4. COMMUNICATION CONDUCTORS ON UNGUYED SUPPORTS AT RAILROAD CROSSINGS

The longitudinal loading shall be assumed equal to an unbalanced pull in the direction of the

252. C. Assumed Longitudinal Loading—Continued.

crossing of all open-wire conductors supported, the pull of each conductor being taken as 50 percent of its ultimate strength in the heavy loading district, 33⅓ percent in the medium loading district, and 22¼ percent in the light loading district.

D. Average Span Lengths.

1. GENERAL.

The calculated transverse loads upon poles, towers, and crossarms, except as provided in 2 below, shall be based upon the average span length of a section of line that is reasonably uniform as to height, number of wires, grade, and span length. In no case shall the average value taken be less than 75 percent or more than 125 percent of the actual average of the two spans adjacent to the structure concerned.

2. CROSSINGS.

In the case of crossings over railroads or communication lines (other than minor communication lines) the actual lengths of the two spans adjacent to the two structures concerned shall be used.

E. Simultaneous Application of Loads.

1. When calculating transverse strength, the assumed transverse and vertical loads shall be taken as acting simultaneously.
2. In calculating longitudinal strength, the assumed longitudinal loads shall be taken without consideration of the vertical or transverse loads.

SEC. 26. STRENGTH REQUIREMENTS

260. PRELIMINARY ASSUMPTIONS.

It is recognized that deformation, deflection, or displacement of parts of the structure will, in some cases, change the effects of the loads assumed. In the calculation of stresses, however, no allowance shall be made for such

260. Preliminary Assumptions—Continued.

deformation, deflection, or displacement of supporting structures (including poles, towers, guys, crossarms, pins, conductor fastenings, and suspension insulators) unless the methods used to evaluate them have been approved by the administrative authority.

261. GRADES B AND C CONSTRUCTION.

A. Poles and Towers.

The strength requirements for poles and towers may be met by the structures alone or with the aid of guys or braces.

1. AVERAGE STRENGTH OF THREE POLES.

A pole (single-base structure) not individually meeting the transverse strength requirements will be permitted when reinforced by a stronger pole on each side, if the average strength of the three poles meets the transverse strength requirements, and the weak pole has not less than 75 percent of the required strength.

An extra pole inserted in a normal span for the purpose of supporting a service loop may be ignored, if desired, in the calculation of the strength of the line.

Exception: In the case of crossings over railroads or communication lines (other than minor communication lines), the actual strengths of the crossing poles shall be used.

2. REINFORCED-CONCRETE POLES.

Reinforced-concrete poles shall be of such material and dimensions as to withstand, for vertical and transverse strength, the loads assumed in rules 252, A and B, and for longitudinal strength the loads in rule 252, C, without exceeding the following percentages of their ultimate strength at the ground line for unguyed poles, or at the point of guy attachment for guyed poles. (Where guys are used, see rule 261, C.)

261. A. Poles and Towers—Continued.

	Percentages of ultimate strength for reinforced-concrete poles	
	Grade B	Grade C
For transverse strength (when installed)	25	37. 5
For longitudinal strength (at all times):		
In general	100	No requirement.
At dead-ends	50	75. 0

3. STEEL SUPPORTING STRUCTURES.

In the design of steel structures, the term "overload capacity factor" referred to in table 16 is to be interpreted in such a manner that the completed structure, if tested, shall support without permanent deflection the maximum loading to which it will be subjected as specified in section 25, multiplied by the factors given in table 16. The absence of permanent set on the structure indicates that no part has been stressed beyond the yield point. Allowance should be made for bolt slip.

Steel supports, steel towers, and metal poles shall be designed and constructed so as to meet the following requirements:

(a) VERTICAL AND TRANSVERSE STRENGTH. The completed structure shall be so designed and of sufficient strength as to provide overload capacity factors specified in table 16 under the vertical and transverse loading specified in rule 252, A and B, 1 to 5, inclusive.

(b) LONGITUDINAL STRENGTH.

Grade B. The completed structure shall be so designed and of sufficient strength as to provide overload capacity factors

261. A. Poles and Towers—Continued.

specified in table 16 under the longitudinal loading specified in rule 252, C.

Grade C. No longitudinal strength requirements except at dead-ends.

(c) MINIMUM STRENGTH. Steel structures shall have strength sufficient to withstand, with an overload capacity factor of 1.1, a transverse load on the structures without conductors, equal to six times the specified wind pressure.

(d) STRENGTH AT ANGLES IN A LINE. At an angle in a line having supports of steel poles or towers, the strength of the support shall be sufficient to withstand a combination of the transverse and longitudinal loadings specified in rule 252, B, 6. For grade B the transverse load shall be multiplied by 1.54, and for grade C by 2.00, before combining with the load arising from change in direction of conductors. The allowable overload capacity factor at dead-ends given in table 16 shall be provided for the total load thus computed.

TABLE 16.—*Minimum overload capacity factors of completed structures*

[Based on yield point of steel]

	Overload capacity factors	
	Grade B	Grade C
Vertical strength	1.27	1.10
Transverse strength	2.54	2.20
Longitudinal strength:		
At crossings—		
In general	1.10	No requirement.
At dead-ends	1.65	1.10
Elsewhere—		
In general	1.00	No requirement.
At dead-ends	1.65	1.10

261. A. Poles and Towers—Continued.

(e) THICKNESS OF STEEL. The thickness of metal in members of steel poles or towers shall be not less than the following:

TABLE 17.—*Thickness of steel*

	Thickness of main members of crossarms and legs	Thickness of other members
	Inches	*Inches*
For localities where experience has shown deterioration of protective covering is rapid	1/4	3/16
For other localities	3/16	1/8

(f) UNSUPPORTED LENGTH OF COMPRESSION MEMBERS. The ratio of L, the unsupported length of a compression member, to R, the least radius of gyration of the member, shall not exceed the following (these figures do not apply to the complete structure):

TABLE 18.—*L/R for compression members*

Kind of compression member	L/R
Leg members	150
Other members having figured stresses	200
Secondary members without figured stresses	250

(g) GENERAL CONSTRUCTION FEATURES. Steel poles or towers, including parts of footings above ground, shall be constructed so that all parts are accessible for inspection, cleaning, and painting, and so that pockets are not formed in which water can collect.

Recommendation: Unless sample structures, or similar ones, have been tested to assure the compliance of structures in any line with these

261. A. Poles and Towers—Continued.

requirements, it is recommended that structures be designed to have a computed strength at least 10 percent greater than that required by these rules.

(h) PROTECTIVE COVERING OR TREATMENT. All iron or steel poles, towers, or supporting structures shall be protected by galvanizing, painting, or other treatment which will effectively retard corrosion. Such protective covering shall be adequately maintained.

4. WOOD POLES.

Wood poles shall be of such material and dimensions as to meet the following requirements (where guys are used, see rule 261, C):

(a) TRANSVERSE STRENGTH. Wood poles shall withstand the transverse and vertical loads assumed in rule 252, A and B, 1 to 4, inclusive, without exceeding at the ground line for unguyed poles, or at the point of guy attachment for guyed poles, the appropriate allowable percentages of their ultimate stress given in table 20.

(b) LONGITUDINAL AND DEAD-END STRENGTH. The longitudinal and dead-end strength of wood poles shall be such that they will withstand the appropriate longitudinal loading specified in rule 252, C, without exceeding, at the ground line for unguyed poles or at the point of guy attachment for guyed poles, the following percentages of the applicable ultimate fiber stress given in table 19.

261. A. Poles and Towers—Continued.

	Percentages of ultimate fiber stress for wood poles	
	Grade B	Grade C
Longitudinal:		
When installed	[1] 75	No requirement.
At replacement	100	Do.
Dead-ends:		
When installed	[1] 50	[1] 75
At replacement	75	100

[1] Where supply lines alone are involved and built for a fixed period of temporary service not exceeding 5 years the prescribed percentage of fiber stress at installation may be increased, provided the percentage of ultimate fiber stress required at replacement is not exceeded during the life of the line.

Exception 1: At a Grade B crossing, in a straight section of line, wood poles of approximately round cross section, complying with the transverse strength requirements of rule 261, A, 4 (a), without the use of transverse guys, shall be considered as having the required longitudinal strength. This exception does not modify the requirements of this rule for dead-ends.

Exception 2: At a grade B crossing of a supply line over a highway and a communication line in the same span, where there is an angle in the supply line, wood poles of approximately round cross section shall be considered as having the required longitudinal strength if all of the following conditions obtain:

1. The angle is not over 20 degrees.
2. The corner pole is guyed in the plane of the resultant of the conductor tensions on both sides of the corner pole; the tension in this guy not to exceed 50 percent of its ultimate strength under the loading of rule 252, B, 6.

261. A. Poles and Towers—Continued.

3. The corner pole has sufficient strength to withstand, without guys, the transverse loading of rule 252, B, 1, 2 or 3, which would exist if there were no angle at that pole, without exceeding 25 percent of its ultimate stress when installed, or 37½ percent at replacement.

(c) ULTIMATE FIBER STRESS. Different kinds of wood poles are considered as having the ultimate fiber stresses given in table 19.

TABLE 19.—*Ultimate fiber stresses of wood poles*

Kind of wood	Ultimate fiber stress
	lb/sq in.
Creosoted southern pine	7, 400
Douglas fir	7, 400
Lodgepole pine	6, 600
Chestnut	6, 000
Western red cedar	5, 600
Cypress	5, 000
Northern white cedar	3, 600
Redwood	3, 600

When values for ultimate stresses of cypress and redwood have been approved as standard by the American Standards Association, such values shall be used in place of those given above.

(d) ALLOWABLE PERCENTAGES OF ULTIMATE STRESS. The allowable percentages of ultimate stress of treated and untreated poles to withstand vertical and transverse loads are given in table 20, except as modified in the following paragraph.

At crossings where grade B construction is required, if the supply line is not maintained throughout (or between and including the nearest guyed points on each side of the crossing) so that the poles will not be stressed at any time in excess of 50 percent

261. A. Poles and Towers—Continued.

of their ultimate stress under the transverse loading assumed in rule 252, B, the crossing poles, if unguyed, shall be of such strength that they will withstand the transverse loading assumptions of rule 252 B, 1, 2, or 3, without exceeding 16⅔ percent of their ultimate stress at installation or 25 percent at replacement. If the crossing poles are side guyed, such guys shall meet the requirements of rule 261, C, 5.

TABLE 20.—*Allowable percentages of ultimate stress for treated or untreated wood poles under vertical and transverse loading*

	When installed	At replacement
Grade B	25.0	37.5
Grade C:		
At crossings	37.5	75.0
Elsewhere	50.0	75.0

(e) FREEDOM FROM DEFECTS. Wood poles shall be of suitable and selected timber free from observable defects that would decrease their strength or durability.

(f) MINIMUM POLE SIZES. Wood poles shall have a nominal top circumference of not less than 15 inches.

(g) SPLICED AND STUB-REINFORCED POLES. Spliced poles shall not be used at crossings, conflicts, or joint-use sections requiring grades B or C construction.

Except at crossings over major railroad tracks, the use of stub reinforcements that develop the required strength of the pole is permitted, provided the pole above the ground is in good condition and is of sufficient size to develop its required strength.

261. A. Poles and Towers—Continued.

5. TRANSVERSE-STRENGTH REQUIREMENTS FOR STRUCTURES WHERE SIDE GUYING IS REQUIRED, BUT CAN ONLY BE INSTALLED AT A DISTANCE.

Grade B. In the case of structures where, because of very heavy or numerous conductors or relatively long spans, the transverse-strength requirements of this section can not be met except by the use of side guys or special structures, and it is physically impracticable to employ side guys, the transverse-strength requirements may be met by side-guying the line at each side of, and as near as practicable to, the crossing or other transversely weak structure, and with a distance between such side-guyed structures of not over 800 feet, provided that:

(a) The side-guyed structures for each such section of 800 feet or less shall be constructed to withstand the calculated transverse load due to wind on the supports and ice-covered conductors, on the entire section between the side-guyed structures.

(b) The line between such side-guyed structures shall be substantially in a straight line and the average length of span between the side-guyed structures shall be not in excess of 150 feet.

(c) The entire section between the transversely strong structures shall comply with the highest grade of construction concerned in the given section, except as to the transverse strength of the intermediate poles or towers.

Grade C. The above provision is not applicable to grade C.

261. A. Poles and Towers—Continued.

6. LONGITUDINAL-STRENGTH REQUIREMENTS FOR SECTIONS OF HIGHER GRADE IN LINES OF A LOWER GRADE OF CONSTRUCTION.

(a) METHODS OF PROVIDING LONGITUDINAL STRENGTH.

Grade B. The longitudinal-strength requirements for sections of line of higher grade in lines of a lower grade (for assumed longitudinal loading, see rule 252, C, 1) are usually met by placing supporting structures of the required longitudinal strength at either end of the higher-grade section of the line.

Where this is impracticable, the supporting structures of the required longitudinal strength may be located one or more span lengths away from the section of higher grade, within 500 feet on either side and with not more than 800 feet between the longitudinally strong structures, provided such structures and the line between them meet the requirements as to transverse strength and stringing of conductors, of the highest grade occurring in the section, and provided that the line between the longitudinally strong structures is approximately straight or suitably guyed.

The requirements may also be met by distributing the head guys over two or more structures on either side of the crossing, such structures and the line between them complying with the requirements for the crossing as to transverse strength and as to conductors and their fastenings.

Where it is impracticable to provide the longitudinal strength, the longitudinal loads shall be reduced by increasing the conductor sags. This may require greater conductor separations. (See rule 235, A, 2, (a).)

Grade C. The above provision is not applicable to grade C.

261. A. Poles and Towers—Continued.

(b) FLEXIBLE SUPPORTS.

Grade B. When supports of the section of higher grade are capable of considerable deflection in the direction of the line, as with wood or concrete poles, or some types of metal poles and towers, it may be necessary to increase the normal clearances specified in section 23, or to provide head guys or special reinforcement to prevent such deflection.

So-called flexible steel towers or frames, if used at such locations, shall be adequately reinforced to meet the requirements of rule 261, A, 3 (b).

When the situation is one involving an isolated crossing of higher grade in a line of lower-grade construction, then the structure shall, when practicable, be head-guyed or otherwise reinforced to prevent reduction in the clearances required in section 23.

Grade C. The above provision is not applicable to grade C.

7. STRENGTH AT ANGLES IN A LINE.

At an angle in the line, the strength of a pole at the ground line, if not guyed, or at the point of guy attachment if guyed, shall be sufficient to withstand a combination of the transverse and longitudinal loadings specified in rule 252, B, 6. For grade B the transverse load shall be multiplied by 2.0 and for grade C by 1.5, before combining with the load arising from change in direction of conductors. The allowable percentage of ultimate stress at dead-ends given in rule 261, A, 4 (b) shall not be exceeded for the total load thus computed.

261. Grades B and C Construction—Continued.

B. Foundations.

1. USE OF FOUNDATIONS.

(a) WOOD AND REINFORCED-CONCRETE POLES. No special foundation construction is generally required.

(b) STEEL POLES OR TOWERS. Steel poles or towers set in earth shall be suitably protected against injurious corrosion at and below the ground line.

2. STRENGTH OF FOUNDATIONS.

(a) STEEL SUPPORTS. The foundations and footings shall be so designed and constructed as to withstand the stresses due to the loads assumed in rule 252. Steel parts shall withstand these loads with the overload capacity factors specified in table 16.

Since in many localities the soil and climatic conditions are such as to alter the strength of foundations considerably from time to time, there should usually be provided a considerable margin of strength in foundations above that which (by calculation) will just withstand the loads under the assumption of average conditions of climate and soil.

(b) WOOD AND CONCRETE POLES. Foundations and settings for unguyed poles shall be such as to withstand the loads assumed in rule 252 A, B, and C.

C. Guys.

1. GENERAL.

The general requirements for guys are covered under "Miscellaneous Requirements" (sec. 28).

2. FOR POLES IN INSECURE EARTH.

Where crossing poles are set in insecure earth the transverse strength requirements should, where practicable, be met by the use of side guys or braces.

261. C. Guys—Continued.

3. ON STEEL STRUCTURES.

The use of guys to obtain compliance with these requirements is regarded as generally undesirable. When guys are necessarily used, the steel supports or towers, unless capable of considerable deflection, shall be regarded as taking all of the load up to their allowable working load, and the guys shall have sufficient strength to take the remainder of the assumed maximum load. (See rule 261, A, 6, (b) for flexible supports.)

4. ON WOOD OR CONCRETE POLES.

When guys are used to meet the strength requirements for wood or concrete poles, they shall be considered as taking the entire load in the direction in which they act, the poles acting as struts only. Frequently the use of shorter spans or larger poles will permit the omission of guys at crossings.

5. STRENGTH OF GUYS.

(a) Guys, when required, shall be of such material and dimensions as will withstand the transverse loads assumed in rule 252, B, 1 to 5, inclusive, and the longitudinal load assumed in rule 252, C, without exceeding the following percentages of their ultimate strength:

	Percentages of ultimate strength	
	Grade B	Grade C
For transverse strength (when installed)	37. 50	50. 00
For longitudinal strength (at all times):		
In general	100. 00	No requirement.
At dead-ends	[1] 66. 67	[1] 87. 50

---

[1] If deflection of supporting structures is taken into account in the computations, 66⅔ percent shall be reduced to 60 percent and 87½ percent shall be reduced to 75 percent.

261. C. Guys—Continued.

(b) At an angle in the line, the strength of a transverse guy or guys shall be sufficient to withstand the combination of transverse and longitudinal loadings specified in rule 252, B, 6. The transverse load shall be multiplied by 1.78 for both grades B and C before combining with the load arising from the change in direction of conductors. The allowable percentage of ultimate strength at dead-ends given in (a) above shall not be exceeded for the total load thus computed.

D. Crossarms.

1. VERTICAL STRENGTH.

Crossarms shall, when installed, withstand the vertical loads specified in rule 252, A without the stress under these loads exceeding 50 percent of the assumed ultimate stress of the material.

Exception: For built up steel crossarms on steel structures, see table 16 for minimum overload capacity factors.

2. BRACING.

Crossarms shall be securely supported by bracing, if necessary, so as to support safely all other loads to which they may be subjected in use, including linemen working on them. Any crossarm or buckarm except the top one shall be capable of supporting a vertical load of 225 pounds at either extremity in addition to the weight of the conductors.

3. LONGITUDINAL STRENGTH.

(a) GENERAL. Crossarms shall withstand any unbalanced longitudinal loads to which they are exposed, with a limit of unbalanced tension where conductor pulls are normally balanced, of 700 pounds at the outer pin.

261. D. Crossarms—Continued.

(b) AT DEAD-ENDS AND AT ENDS OF HIGHER-GRADE CONSTRUCTION IN LINE OF LOWER GRADE.

Grade B. Wood crossarms shall be of sufficient strength to withstand at all times, without exceeding their ultimate stresses, an unbalanced pull equal to the tension in all supported conductors under the assumed conductor loading given in rule 251. Steel arms shall withstand this load with the overload capacity factor for longitudinal loads given in table 16.

Grade C. The above provisions do not apply to grade C.

(c) AT ENDS OF TRANSVERSELY WEAK SECTIONS.

Grade B. The crossarms connected to the structure at each end of the transversely weak section, such as described in rule 261, A, 5, shall be such as to withstand at all times without exceeding their ultimate stresses, under the conductor loading prescribed in rule 251, an unbalanced load equivalent to the combined pull in the direction of the transversely weak section of all the conductors supported.

Grade C. The above provision does not apply to grade C.

(d) METHODS OF MEETING RULES 261, D, 3, (b) AND (c).

Grade B. Where conductor tensions are limited to a maximum of 2,000 pounds per conductor, double wood crossarms fitted with spacing bolts equipped with spacing nuts and washers, pipe spacers, or similar construction, or with spacing blocks or plates, will be considered as meeting the

261. D. Crossarms—Continued.

strength requirements in (b) and (c) preceding.

Grade C. The above provisions do not apply to grade C.

4. DIMENSIONS OF CROSSARMS OF SELECTED YELLOW PINE OR FIR.

The cross-sectional dimensions of selected yellow pine or fir crossarms shall be not less than the values of table 21.

TABLE 21.—*Crossarm cross sections*

Number of pins	Grade B	Grade C	
		Supply	Communication
	Inches	*Inches*	*Inches*
2 or 4	3 by 4	2¾ by 3¾	
6 or 8	3¼ by 4¼	3 by 4	
6			2¾ by 3¾
10			3 by 4

5. DOUBLE CROSSARMS OR BRACKETS.

Grade B. Where pin-type construction is used, two points of support shall be provided for each conductor by means of double crossarms or double brackets at each crossing structure, at ends of joint use or conflict sections, at dead-ends, and at corners where the angle of departure from a straight line exceeds 20 degrees.

Exception: Where communication cables or conductors cross below supply conductors and are attached to the same pole, the above does not apply unless another condition which requires double pins and fastenings for the supply conductors is involved.

Grade C. The above provision applies to grade *C* where supply conductors of more than 5,000

261. D. Crossarms—Continued.

volts between wires (or of more than 2,900 volts to ground in the case of grounded neutral circuits) cross over minor communication lines at locations such that the supply pole is more than 6 feet from the nearest communication conductor, unless other means of providing equivalent safety and strength are agreed to by the parties involved.

6. LOCATION.

In general, crossarms should be maintained at right angles to the axis of the pole and to the direction of the attached conductors. At crossings, crossarms should be attached to that face of the structure away from the crossing, unless special bracing or double crossarms are used.

E. Pins and Conductor Fastenings.

1. LONGITUDINAL STRENGTH

(a) GENERAL. Pins and ties or other conductor fastenings shall have sufficient strength to withstand an unbalanced tension in the conductor, up to a limit of 700 pounds per pin or fastening.

(b) AT DEAD-ENDS AND AT ENDS OF HIGHER-GRADE CONSTRUCTION IN LINE OF LOWER GRADE.

Grade B. Pins and ties or other conductor fastenings connected to the structure at each end of the higher-grade section shall be of sufficient strength to withstand at all times without exceeding their ultimate strength, an unbalanced pull due to the conductor loading specified in rule 251.
Grade C. The above provisions do not apply to grade C.

(c) AT ENDS OF TRANSVERSELY WEAK SECTIONS.

Grade B. Pins and ties or other conductor fastenings connected to the structure at

261. E. Pins and Conductor Fastenings—Continued.

each end of the transversely weak section as described in rule 261, A, 5 shall be such as to withstand at all times without exceeding their ultimate strength under the conductor loading prescribed in rule 251, the unbalanced pull in the direction of the transversely weak section of the conductor supported.

Grade C. The above provisions do not apply to grade C.

(d) METHOD OF MEETING RULES 261, E, 1, (b), AND (c).

Grade B. Where conductor tensions are limited to 2,000 pounds and such conductors are supported on pin insulators, double pins, and ties or equivalent fastenings will be considered to meet the requirements of (b) and (c) preceding.

Grade C. The above provision does not apply to grade C.

2. SHARP EDGES ON FASTENINGS.

Tie wires, fastenings, or supports shall have no sharp edges or burrs at contacts with the conductors.

3. HEIGHT OF PIN.

The height of the pin and the conductor fastenings and the material and cross section of the pin should be chosen so as to afford the required strength.

Note: The method of attaching conductors by suitable ties to single pin-type insulators mounted on 1½ by 9 inch wood pins of locust or equivalent wood will usually provide strength up to 1,000 pounds conductor tension with the conductor 3.5 inches above the crossarm. Steel pins may afford greater strength, both for the pins and for the crossarms.

261. E. Pins and Conductor Fastenings—Continued.

4. DOUBLE PINS AND CONDUCTOR FASTENINGS.

Grade B. Where pin-type construction is used, two points of support shall be provided for each conductor by means of double pins and conductor fastenings at each crossing structure, at ends of joint use or conflict sections, at dead-ends, and at angles where the angle of departure from a straight line exceeds 20 degrees.

Exception: Where communication cables or conductors cross below supply conductors and are attached to the same pole, the above does not apply unless another condition which requires double pins and fastenings for the supply conductors is involved.

Grade C. The above provision applies to grade C where supply conductors of more than 5,000 volts between wires (or of more than 2,900 volts to ground in the case of grounded neutral circuits) cross over minor communication lines at locations such that the supply pole is more than 6 feet from the nearest communication conductor, unless other means of providing equivalent safety and strength are agreed to by the parties involved.

F. Open Supply Conductors.

1. MATERIAL.

Conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

Recommendation: It is recommended that hard-drawn or medium-hard-drawn copper wire (conforming to the specifications of the American Society for Testing Materials) be used instead of soft in new construction where bare wire or cable is used, especially for sizes smaller than No. 2.

261. F. Open Supply Conductors—Continued.

2. MINIMUM SIZES OF SUPPLY CONDUCTORS.

Supply conductors, both bare and covered, shall have an ultimate strength and an over-all diameter of metallic conductor not less than that of medium-hard-drawn copper of the gage size AWG shown in table 22, except that conductors made entirely of bare or galvanized iron or steel shall have an over-all diameter not less than Stl. WG of the gage sizes shown.

Exception 1: At railroad crossings, for stranded conductors, other than those in which a central core wire is entirely covered by the outside wires, any individual wire of such a stranded conductor containing steel shall be not less than 0.100 inch in diameter if copper-covered and not less than 0.115 inch in diameter if otherwise protected or if bare.

Exception 2: Supply service leads of 0 to 750 volts to ground may have the sizes set forth in rule 263, E.

Exception 3: Where the short-span method of construction is employed in accordance with rule 261, K, the conductor sizes and sags herein specified are not required.

TABLE 22.—*Minimum over-all conductor sizes*

Grade of construction	Gage size [1]
B	6
C	8

[1] For No. 6 and No. 8 medium-hard-drawn copper wire the nominal diameters are 0.1620 and 0.1285 inch, and the minimum values of breaking load are 1,010 and 643.9 pounds, respectively. For steel wire gage the nominal diameters are 0.192 inch for No. 6 and 0.162 inch for No 8.

3. LIGHTNING PROTECTION WIRES.

Lightning-protection wires paralleling the line conductors shall be regarded in respect to size, material, and stringing requirements as supply conductors with which they are associated.

261. F. Open Supply Conductors—Continued.

4. SAGS AND TENSIONS.

Conductor sags shall be such that, under the assumed loading of rule 251 for the district concerned, the tension of the conductor shall be not more than 60 percent of its ultimate strength. Also the tension at 60° F, without external load, shall not exceed the following percentages of the conductor ultimate strength:

Initial unloaded tension	35 percent.
Final unloaded tension	25 percent.

Exception: In the case of conductors having a cross section of a generally triangular shape, such as cables composed of three wires, the final unloaded tension at 60° F shall not exceed 30 percent of the ultimate strength of the conductor.

Note: The above limitations are based on the use of recognized methods for avoiding fatigue failures by minimizing chafing and stress concentration. If such practices are not followed, lower tensions should be employed.

5. SPLICES AND TAPS.

Grade B. Splices shall as far as practicable be avoided in the crossing and adjacent spans. If it is impracticable to avoid such splices, they shall be of such a type and so made as to have a strength substantially equal to that of the conductor in which they are placed.

Taps shall be avoided in the crossing span where practicable, but if required shall be of a type which will not impair the strength of the conductors to which they are attached.

Grade C. The above does not apply to grade C.

6. TROLLEY CONTACT CONDUCTORS.

In order to provide for wear, no trolley contact conductor shall be installed of less size than No. 0, if of copper, or No. 4, if of silicon bronze.

261. Grades B and C Construction—Continued.

G. Supply Cables.

1. SPECIALLY INSTALLED SUPPLY CABLES.

Cables having effectively grounded continuous metal sheath or armor, where located on jointly used poles, or where located on other poles and having a grade of construction less than that required for open wire supply lines of the same voltage, shall meet the requirements of (a), (b), (c), and (d) below.

(a) Messengers. Messengers shall be stranded and of corrosion-resistant material, and shall not be stressed beyond 60 percent of their ultimate strength under the loadings specified in rule 251.

(b) Grounding of Cable Sheath and Messenger. Each section of cable between splices shall be suitably and permanently bonded to the messenger wire at not less than two places. The messenger wire shall be grounded at the ends of the line and at intermediate points not exceeding 800 feet apart. (See section 9 for method.)

(c) Cable Splices. Splices in the cable shall be made so that their insulation is not materially weaker than the remainder of the cable. The sheath or armor at the splice shall be made electrically continuous.

(d) Cable Insulation. The conductors of the cable shall be insulated so as to withstand a factory potential test of at least twice the operating voltage at operating frequency applied continuously for 5 minutes between conductors and between any conductor and the sheath or armor.

261. G. Supply Cables—Continued.

2. OTHER SUPPLY CABLES.

The following requirements apply to all supply cables not included in 1 above.

(a) MESSENGER. The messenger shall be of corrosion-resistant material, and shall not be stressed beyond 60 percent of its ultimate strength under the loadings specified in rule 251.

(b) CABLE. There are no strength requirements for cables supported by messengers.

H. Open-wire Communication Conductors.

Open-wire communication conductors in grade B or C construction shall have the sizes and sags given in rule 261, F, 2 and 4 for supply conductors of the same grade.

Exception: Where open-wire communication conductors in spans of 150 feet or less are above supply circuits of 5,000 volts or less between conductors, grade C sizes and sags may be replaced by grade D sizes and sags, except that where the supply conductors are trolley-contact conductors of 0 to 750 volts to ground, No. 12 wire may be used for spans of 0 to 100 feet, and No. 9 steel wire may be used for spans of 125 to 150 feet.

I. Communication Cables.

1. METAL-SHEATHED COMMUNICATION CABLES.

There are no strength requirements for such cables supported by messengers.

2. MESSENGER.

The messenger shall be of corrosion-resistant material, and shall not be stressed beyond 60 percent of its ultimate strength under the loadings specified in rule 251.

261. Grades B and C Construction—Continued.

J. Paired Communication Conductors.

1. PAIRED CONDUCTORS SUPPORTED ON MESSENGER.

(a) USE OF MESSENGER. A messenger of corrosion-resistant material may be used for supporting paired conductors in any location, but is only required for paired conductors crossing over trolley-contact conductors of more than 7,500 volts to ground.

(b) SAG OF MESSENGER. Messenger used for supporting paired conductors required to meet grade B construction because of crossing over trolley-contact conductors shall meet the sag requirements for grade D messengers.

(c) SIZE AND SAG OF CONDUCTORS. There are no requirements for paired conductors when supported on messenger.

2. PAIRED CONDUCTORS NOT SUPPORTED ON MESSENGER.

(a) ABOVE SUPPLY LINES.

Grade B. Sizes and sags shall be not less than those required by rule 261, F, 2 and 4 for supply conductors of similar grade.

Grade C. Sizes and sags shall be not less than the following:

Spans 0 to 100 feet. No sag requirements. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds.

Spans 100 to 150 feet. Sizes and sags shall be not less than required for grade D communication conductors.

Spans exceeding 150 feet. Sizes and sags shall be not less than required for grade C supply conductors. (See rule 261, F, 4.)

261. J. Paired Communication Conductors—Continued.

(b) ABOVE TROLLEY-CONTACT CONDUCTORS.

Grade B. Sizes and sags shall be not less than the following:

Spans 0 to 100 feet. No size requirements. Sags shall be not less than for No. 8 AWG hard-drawn copper. (See rule 261, F, 4.)

Spans exceeding 100 feet. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds. Sags shall be not less than for No. 8 AWG hard-drawn copper. (See rule 261, F, 4.)

Grade C. Sizes and sags shall be as follows:

Spans 0 to 100 feet. No requirements.

Spans exceeding 100 feet. No sag requirements. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds.

K. Short-Span Crossing Construction.

Where supply lines cross over railways or communication lines by the short-span method, the requirements for grade B or C conductor sags and sizes are waived, in so far as such grades are required by the crossing, provided that an effectively grounded guard arm is installed at each cross-over support in such a manner as to prevent conductors which break in either adjoining span from swinging back into the conductors crossed over, or in the case of a railroad crossing into the space between the crossing supports.

Note: The short-span method of crossing requires the cross-over span to be of such a height that a conductor breaking in that span cannot come within 15 feet of the ground or rails at a railroad crossing or make contact with any wires crossed over at a wire crossing.

This character of construction is facilitated where the cross-over supports can be placed quite near together and in the case of wire crossings where the span crossed over is at a minimum elevation above ground.

261. Grades B and C Construction—Continued.

L. Cradles at Supply-Line Crossings.

Cradles should not be used.

Note: It is less expensive and better to build the supply line strong enough to withstand extreme conditions than to build a cradle of sufficient strength to catch and hold the supply line if it falls.

M. Protective Covering or Treatment for Metal Work.

All hardware, including bolts, washers, guys, anchor rods, and similar parts of material, subject to injurious corrosion under the prevailing conditions, shall be protected by galvanizing, painting, or other treatment which will effectively retard corrosion.

262. GRADE D CONSTRUCTION.

A. Poles.

1. STRENGTH OF UNGUYED POLES.

Unguyed poles, except as provided in rule 262, A, 8, shall withstand the vertical and transverse loads specified in rule 252, A and B, and the longitudinal loads specified in rule 252, C, 4, without exceeding the following percentages of their ultimate stress:

	Percentages of ultimate stress
For transverse loads:	
When installed	25. 0
At replacement	37. 5
For longitudinal loads:	
When installed	75. 0
At replacement	100. 0

2. STRENGTH OF GUYED POLES.

Where poles are guyed, the poles shall be considered as acting as struts, resisting the vertical component of the tension in the guy, calculated as in rule 262, C, combined with the vertical load.

262. A. Poles—Continued.

3. STRENGTH REQUIREMENTS FOR POLES WHERE GUYING IS REQUIRED, BUT CAN ONLY BE INSTALLED AT A DISTANCE.

Where on account of physical conditions it is impracticable to guy or brace the crossing poles as specified in rule 262, C the requirements there given may be met by head-guying and side-guying the line as near as practicable to the crossing, but at a distance not exceeding 500 feet from the nearest crossing pole, provided that the line is approximately straight and that a stranded steel wire or other standard strand of strength equivalent to that of the head guy is run between the two guyed poles, being attached to the guyed poles at the point at which the head guys are attached, this wire being securely attached to every pole between the guyed poles.

4. POLE LOCATIONS AT CROSSINGS.

Where communication lines cross over railroads, the poles shall be located as follows:

(*a*) The poles supporting the crossing span and the adjacent spans should be located in a straight line, if practicable. Where the poles supporting the crossing span and the adjacent spans are not in line, guying shall be placed to take care of the unbalanced load.

(*b*) The crossing span shall, where practicable, not exceed 100 feet in the heavy loading district, 125 feet in the medium loading district, and 150 feet in the light loading district.

5. FREEDOM FROM DEFECTS.

Wood poles shall be of suitable and selected timber free from observable defects that would decrease their strength or durability.

262. A. Poles—Continued.

6. MINIMUM POLE SIZE.

Wood poles shall have a nominal top circumference of not less than 15 inches.

7. SPLICED AND STUB-REINFORCED POLES.

Spliced poles shall not be used at grade D crossings. At crossings over minor railroad tracks, the use of stub-reinforcements that develop the required strength of the pole is permitted, provided the pole above the ground line is in good condition and is of sufficient size to develop its required strength.

8. POLES LOCATED AT CROSSINGS OVER SPUR TRACKS.

Where a communication line paralleling a railroad track on the right-of-way of the railroad crosses a spur or stub track without any change in the general direction of line, the transverse strength requirements for grade D construction may be met without the use of side guys, provided the pole is not stressed beyond one-third of its ultimate stress. No requirements for longitudinal strength are made if the conductor tensions are balanced. Where conductor tensions are not balanced, due to a small angle in the line at one or both poles, or to dead-ending any of the wires, either guys or braces capable of withstanding such unbalanced tensions shall be installed.

B. Pole Settings.

Foundations and settings for unguyed poles shall be such as to withstand the loads assumed in rule 252, A, B, and C.

C. Guys.

1. GENERAL.

The general requirements for guys are covered under "Miscellaneous Requirements" (sec. 28).

262. C. Guys—Continued.

2. WHERE USED.

Side guys or braces shall be used on poles supporting the crossing span to withstand the loads put upon them in accordance with the conditions specified in rule 252, B.
Head guys shall be installed in accordance with table 23.

Exception 1: Side guys are not required where the crossing poles have the transverse strength specified in rule 262, A, 1 without the reduction for conductor shielding specified in rule 252, B, 1 and 2.

Exception 2: Head guys are not required where the crossing poles have the longitudinal strength specified in rule 262, A, 1, or where they carry a cable supported on 6,000-pound or stronger messenger.

Exception 3: Where a line crossing a railroad changes direction more than 10 degrees at either crossing support, the side guy within the angle may be omitted and the head guy, if required, shall be placed in the direction of the adjacent span unless the angle of turn is greater than 60 degrees.

Exception 4: Guying may be omitted where communication lines cross over spur or stub tracks as provided in rule 262, A, 8.

Exception 5: This rule does not apply to crossing poles under the special conditions set forth in rule 262, A, 3.

262. C. Guys—Continued.

Table 23.—*Strength (in pounds) of head guys required for loading districts indicated* [1]

[Combinations of standard-size guys may be used]

Number of wires	Ratio of guy lead to height not less than—				
	1¼	1	¾	⅔	½
HEAVY LOADING					
2	4,000	4,000	4,000	4,000	4,000
6	4,000	4,000	4,000	4,000	6,000
10	6,000	6,000	6,000	10,000	10,000
20	10,000	10,000	12,000	16,000	16,000
30	16,000	16,000	20,000	20,000	26,000
40	20,000	20,000	26,000	26,000	32,000
50	20,000	20,000	30,000	32,000	42,000
60	26,000	30,000	36,000	36,000	48,000
70	30,000	30,000	40,000	48,000	60,000
80	36,000	40,000	48,000	60,000	70,000
MEDIUM LOADING					
2	4,000	4,000	4,000	4,000	4,000
6	4,000	4,000	4,000	4,000	4,000
10	4,000	4,000	6,000	6,000	6,000
20	6,000	10,000	10,000	10,000	12,000
30	10,000	10,000	12,000	16,000	16,000
40	12,000	16,000	16,000	16,000	20,000
50	16,000	16,000	20,000	20,000	26,000
60	20,000	20,000	26,000	26,000	30,000
70	20,000	20,000	26,000	30,000	36,000
80	26,000	26,000	30,000	32,000	40,000
LIGHT LOADING					
2	4,000	4,000	4,000	4,000	4,000
6	4,000	4,000	4,000	4,000	4,000
10	4,000	4,000	4,000	4,000	4,000
20	4,000	6,000	6,000	6,000	10,000
30	6,000	10,000	10,000	10,000	12,000
40	10,000	10,000	10,000	12,000	16,000
50	10,000	10,000	16,000	16,000	20,000
60	12,000	16,000	16,000	16,000	20,000
70	16,000	16,000	20,000	20,000	26,000
80	16,000	20,000	20,000	26,000	30,000

[1] This table is based on ultimate or breaking strength of guys equal to seven-sixths of the nominal strengths shown in the table and a wire load of 50 percent No. 8 BWG iron and 50 percent No. 9AWG copper with an average pull of 408.75 pounds per wire.

No guy will be required for cable, since the messenger serves as a head guy.

262. C. Guys—Continued.

3. GUYS USED FOR TRANSVERSE STRENGTH.

Side guys used in straight sections of line shall be considered as taking the entire load in the direction in which they act, without exceeding 37.5 percent of their ultimate strength.

4. GUYS USED FOR LONGITUDINAL STRENGTH.

(a) DIRECTION OF HEAD GUYS. Where head guys are required, they shall be installed in the direction away from the crossing.

(b) SIZE AND NUMBER OF HEAD GUYS. Guys, if required for various open-wire loads, shall be in accordance with table 23.

5. MAINTENANCE.

Guys and anchors shall be maintained so that the guys carry the load.

D. Crossarms.

1. MATERIAL.

Wood crossarms supporting the crossing span shall be of yellow pine, fir, or other suitable timber.

2. MINIMUM SIZE.

(a) WOOD CROSSARMS. Wood crossarms shall have a cross section not less than the following:

Maximum number of wires to be carried	Nominal length		Nominal cross section (Inches)
	Feet	Inches	
2	1	4½	2⁵⁄₁₆ by 3⁵⁄₁₆
4	3	4½	2⁵⁄₁₆ by 3⁵⁄₁₆
6	6	0	2¾ by 3¾
10	8	6	2¾ by 3¾
10	10	0	3 by 4
12 [1]	10	0	3¼ by 4¼
16 [2]	10	0	3¼ by 4¼

[1] Where crossarms are bored for ½-inch steel pins, 3-inch by 4¼-inch crossarms may be used.

[2] Permitted in medium and light loading districts only.

262. D. Crossarms—Continued.

(b) Steel or Iron Crossarms. Galvanized or painted iron or steel crossarms of strength equal to wood crossarms may be used.

3. DOUBLE CROSSARMS.

Crossarms and insulators shall be double on the crossing poles. The crossarms shall be held together with properly fitted spacing blocks or bolts placed immediately adjoining the outside pins. Spacing blocks or spacing bolts are not required for two-pin crossarms.

E. Brackets and Racks.

Wood brackets may be used only if used in duplicate or otherwise designed so as to afford two points of support for each conductor. Single metal brackets, racks, drive hooks or other fixtures may be used if designed and attached in such manner as to withstand the full dead-end pull of the wires supported.

F. Pins.

1. MATERIAL.

Insulator pins shall be of steel, wrought iron, malleable cast iron, or locust or equivalent wood.

2. STRENGTH.

Insulator pins shall have sufficient strength to withstand the loads to which they may be subjected.

3. SIZE.

(a) Wood Pins. Wood pins shall be sound and straight-grained with a diameter of shank not less than 1¼ inches.

(b) Metal Pins. Steel or iron pins shall have diameter of shank not less than ½ inch.

G. Insulators.

Each insulator shall be of such pattern, design, and material that when mounted it will withstand without injury and without being pulled off the pin, the ultimate strength of the conductor attached to the insulator.

262. Grade D. Construction—Continued.

H. Attachment of Conductor to Insulator.

The conductors shall be securely tied to each supporting insulator.

I. Conductors.

1. MATERIAL.

Conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

2. SIZE.

Conductors of the crossing span, if of hard-drawn copper or galvanized steel, shall have sizes not less than specified in (a) and (b) below. Conductors of material other than the above shall be of such size and so strung as to have a mechanical strength not less than that of the sizes of copper conductors given in (a) and (b) below.

(a) Spans Not Exceeding 150 Feet. The sizes in table 24 apply for all loading districts.

Table 24.—*Minimum wire sizes*

[AWG for copper; Stl. WG for steel]

Conductor	Spans of 125 feet or less	Spans 125 to 150 feet
Copper, hard-drawn	10	9
Steel, galvanized:		
In general	10	8
In rural districts of arid regions	12	10

(b) Spans Exceeding 150 Feet. If spans in excess of 150 feet are necessary, the size of conductors specified above or the sags of the conductors shall be correspondingly increased.

262. I. Conductors—Continued.

3. PAIRED CONDUCTORS WITHOUT MESSENGERS.

Paired wires without a supporting messenger shall be eliminated as far as practicable and where used shall meet the following requirements:

(a) MATERIAL AND STRENGTH. Each conductor shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions and shall have an ultimate strength of not less than 170 pounds.

(b) LIMITING SPAN LENGTHS. Paired wires shall in no case be used without a supporting messenger in spans longer than 100 feet in the heavy loading district, 125 feet in the medium loading district, and 150 feet in the light loading district.

4. SAGS.

Table 25 specifies the recommended sags for wires shown in table 24.

TABLE 25.—*Stringing sags*

HEAVY AND MEDIUM LOADING DISTRICTS

Length of span	100°F	80°F	60°F	40°F	20°F	0°F
Feet	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
70	5.7	4.4	3.4	2.7	2.2	1.8
75	6.4	5.1	4.0	3.1	2.5	2.1
80	7.4	5.8	4.5	3.5	2.9	2.4
85	8.4	6.6	5.1	4.0	3.2	2.7
90	9.4	7.3	5.7	4.5	3.6	3.0
95	10.0	8.2	6.3	5.0	4.0	3.4
100	11.6	9.0	7.0	5.5	4.5	3.7
110	14.0	11.0	8.5	6.7	5.4	4.5
120	16.6	13.0	10.1	7.9	6.4	5.4
130	19.5	15.3	11.8	9.3	7.6	6.3
140	22.6	17.7	13.7	10.8	8.8	7.3
150	26.0	20.3	15.8	12.4	10.1	8.4

262. I. Conductors—Continued.

TABLE 25.—*Stringing sags*—Continued

LIGHT LOADING DISTRICT

Length of span	110°F	100°F	80°F	60°F	40°F	20°F	10°F
Feet	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
80	5.5	5.0	4.2	3.4	2.8	2.4	2.2
85	6.2	5.7	4.7	3.9	3.2	2.7	2.5
90	7.0	6.4	5.3	4.3	3.6	3.0	2.8
95	7.8	7.1	5.8	4.8	4.0	3.4	3.1
100	8.6	7.9	6.5	5.3	4.4	3.7	3.5
110	10.4	9.5	7.8	6.5	5.4	4.5	4.2
120	12.4	11.3	9.3	7.7	6.4	5.4	5.0
130	14.6	13.3	11.0	9.0	7.5	6.3	5.9
140	16.9	15.4	12.7	10.5	8.7	7.3	6.8
150	19.4	17.7	14.6	12.0	10.0	8.4	7.8

5. SPLICES AND TAPS.

Splices shall as far as practicable be avoided in the crossing and adjacent spans. If it is impracticable to avoid such splices, they shall be of such a type and so made as to have a strength substantially equal to that of the conductor in which they are placed.

Taps shall be avoided in the crossing span where practicable, but if required shall be of a type which will not impair the strength of the conductors to which they are attached.

J. Messengers.

1. MINIMUM SIZE.

(*a*) SPANS NOT EXCEEDING 150 FEET. Table 26 gives the minimum sizes of galvanized steel-strand messenger to be used for supporting different sizes of cables:

TABLE 26.—*Minimum sizes of messenger*

Size of cable in weight per foot	Messenger (nominal breaking load)
	Pounds
Less than 2.25 pounds	6,000
2.25 to 5 pounds	10,000
Exceeding 5 and less than 8.5 pounds	16,000

262. J. Messengers—Continued.

(*b*) SPANS EXCEEDING 150 FEET. For spans exceeding 150 feet or for heavier cables a proportionately larger messenger or other proportionately stronger means of support shall be used.

2. SAGS AND TENSIONS.

Multiple-conductor cables and their messengers shall be so suspended that when they are subjected to the loading prescribed in rule 251, the tension in the messenger will not exceed 60 percent of its ultimate strength.

K. Inspection.

See rule 213.

263. GRADE N CONSTRUCTION.

A. Poles and Towers.

Poles used for lines for which neither grade B, C, or D is required shall be of such initial size and so guyed or braced, where necessary, as to withstand safely the loads to which they may be subjected, including linemen working on them. Such poles and stubs on State and Federal highways shall be located as far as practicable from the traveled portion of such highways. The number of crossings over such highways should be kept to a minimum. Such poles and stubs located within falling distance of the traveled portion of such highways, or so located that their failure would permit wires, cables, guys, or other equipment to fall into the traveled portion of the highway, or would reduce the clearances specified in table 1 over the traveled portion of such highways, shall be periodically inspected and maintained in safe condition.

B. Guys.

The general requirements for guys are covered under "Miscellaneous Requirements" (sec. 28).

263. Grade N Construction—Continued.

C. Crossarm Strength.

Crossarms shall be securely supported, by bracing if necessary, so as to support safely loads to which they may be subjected in use, including linemen working on them. Any crossarm, or buckarm, except the top one, shall be capable of supporting a vertical load of 225 pounds at either extremity, in addition to the weight of the conductors.

Note: Double crossarms are generally used at crossings, unbalanced corners, and dead-ends, in order to permit conductor fastenings at two insulators, and so prevent slipping, although single crossarms might provide sufficient strength. To secure extra strength, double crossarms are frequently used, and crossarm guys are sometimes used.

D. Supply-line Conductors.

1. MATERIAL.

All supply-line conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

2. SIZE.

Supply-line conductors shall be not smaller than the following:

TABLE 27.—*Grade N minimum sizes for supply-line conductors*

[AWG for copper and aluminum; Stl. WG for steel]

	Urban	Rural
Soft copper	6	8
Medium or hard-drawn copper	8	8
Steel	9	9
	Urban and rural	
	Spans 150 feet or less	Spans exceeding 150 feet
Stranded aluminum:		
Not reinforced	1	0
Steel-reinforced	6	4

263. D. Supply-line Conductors—Continued.

Recommendation: It is recommended that, except as modified in rule 261, F, 2, these minimum sizes for copper and steel not be used in spans longer than 150 feet for the heavy-loading district, and 175 feet for the medium- and light-loading districts.

E. Supply Services.

1. MATERIAL.

All supply service conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

2. SIZE OF OPEN-WIRE SERVICES.

(a) NOT OVER 750 VOLTS BETWEEN CONDUCTORS. Supply-service leads of not over 750 volts between conductors shall be not smaller than required by (1) or (2) below:

(1) SPANS NOT EXCEEDING 150 FEET. Sizes shall be not smaller than specified in table 28.

TABLE 28.—*Minimum sizes of service leads carrying 750 volts or less*

[All voltages are between conductors except trolley-contact conductors where voltages are to ground]

[AWG for copper; Stl. WG for steel]

Situation	Copper wire		Steel wire
	Soft-drawn	Medium or hard-drawn	
Alone	10	12	12
Concerned with communication conductors	10	12	12
Over supply conductors of—			
0 to 750 volts	10	12	12
750 to 8,700 volts [1]	8	10	12
Exceeding 8,700 volts [1]	6	8	9
Over trolley-contact conductors—			
0 to 750 volts ac or dc	8	10	12
Exceeding 750 volts ac or dc	6	8	9

[1] Installation of service leads of not more than 750 volts above supply lines of more than 750 volts should be avoided where practicable.

263. E. Supply Services—Continued.

(2) SPANS EXCEEDING 150 FEET. Sizes shall be not smaller than required for Grade C. (Rule 261, F, 2.)

(b) EXCEEDING 750 VOLTS BETWEEN CONDUCTORS. Sizes of supply-service leads of more than 750 volts between conductors shall be not less than required for supply-line conductors of the same voltage.

3. SAG, OPEN-WIRE SERVICES.

(a) NOT OVER 750 VOLTS BETWEEN CONDUCTORS. Supply service leads of not over 750 volts between conductors shall have sags not less than shown in table 29.

TABLE 29.—*Sags for open-wire services*

Span lengths	Sag
Feet	*Inches*
100 or less	12.
100 to 125	18.
125 to 150	27.
Exceeding 150	Grade C sags.

(*b*) EXCEEDING 750 VOLTS BETWEEN CONDUCTORS. Supply service leads of more than 750 volts between conductors shall comply as to sags with the requirements for supply line conductors of the same voltage.

4. CABLED SERVICES.

Supply service leads may be grouped together in a cable, provided the following requirements are met:

(*a*) SIZE. The size of each conductor shall be not less than required for leads of separate conductors (rule 263, E, 2).

(*b*) SAG. The sag of the cable should be not less than required for leads of separate conductors (rule 263, E, 3).

263. E. Supply Services—Continued.

(*c*) Insulation. The insulation should be sufficient to withstand twice the normal operating voltage.

F. Lightning-Protection Wires.

Lightning-protection wires paralleling the line conductors shall be regarded, in respect to size and material requirements, as supply conductors.

G. Trolley-Contact Conductors.

In order to provide for wear, no trolley-contact conductors shall be installed of less size than No. 0, if of copper, or No. 4, if of silicon bronze.

H. Cradles at Supply-Line Crossings.

Cradles should not be used.

Note: It is less expensive and better to build the supply line strong enough to withstand extreme conditions than to build a cradle of sufficient strength to catch and hold the supply line if it falls.

I. Communication Conductors.

There are no specific requirements for grade N communication line conductors or service drops.

SEC. 27. LINE INSULATORS

270. Application of Rule.

These requirements apply only to supply lines in situations where grade B construction is required. (See rule 242, E, for insulation requirements for neutral conductors.)

271. Material and Marking.

Insulators for operation on supply circuits at voltages of 2,300 and above shall be of porcelain, made by the wet process or one equally suitable as regards electrical and mechanical properties, or other material which will give equally good results in respect to mechanical and electrical performance and durability. They should be marked by the maker with his name, trade-mark, or identification number so applied as not to reduce the electrical or mechanical strength of the insulator.

272. ELECTRICAL STRENGTH OF INSULATORS IN STRAIN POSITION.

Where insulators are used in a strain position they shall have not less electrical strength than the insulators generally used on the line when under the normal mechanical stresses imposed by the loadings specified in section 25.

273. RATIO OF FLASH-OVER TO PUNCTURE VOLTAGE.

Insulators shall be designed so that their dry flash-over voltage is not more than 75 percent of their puncture voltage at a frequency of 60 cycles per second.

274. TEST VOLTAGES.

Insulators when tested under the current specifications of the American Standards Association shall not flash over at values less than given in table 30.

TABLE 30.—*Test-voltage requirements*

[For application see rules 276 and 278]

Nominal voltage between conductors	Minimum test dry flash-over voltage of insulators	Nominal voltage between conductors	Minimum test dry flash-over voltage of insulators
750	5, 000	46, 000	125, 000
2, 400	20, 000	69, 000	175, 000
7, 200	40, 000	115, 000	315, 000
13, 200	55, 000	138, 000	390, 000
23, 000	75, 000	161, 000	445, 000
34, 500	100, 000	230, 000	640, 000

(Interpolate for intermediate values.)

275. FACTORY TESTS.

Each insulator or insulating part thereof for use on circuits operating at voltages in excess of 15,000 volts shall be subjected to a routine dry flash-over test at the factory for a period of 3 minutes at a frequency of 60 cycles per second or to any other test sanctioned by good modern practice, such as high-frequency tests.

276. SELECTION OF INSULATORS.

A. Insulators for Constant-Current Circuits.

Insulators for use on constant-current circuits shall be determined on the basis of the nominal full-load voltage of the circuit.

B. Insulators for Single-phase Circuits Directly Connected to Three-phase Circuits.

Insulators used on single-phase circuits directly connected to three-phase circuits (without intervening isolating transformers) shall have a flash-over voltage not less than that required for the insulators on the three-phase circuits.

C. Insulators for Nominal Voltages Between Conductors.

In selecting insulators of the test voltage to be used for any nominal voltage between conductors, consideration shall be given to the conditions under which the line will operate as follows:

1. Where the system is of moderate extent, in open country, subject to intermittent rains and moderate lightning, insulators having flash-over values not less than given in table 30 shall be used.
2. Where operating conditions are more severe than set forth in 1 above, due to extent of system, prevalence of exceptionally severe lightning, bad atmospheric conditions (caused by chemical fumes, smoke, cement dust, salt fog, or other foreign matter), or to a long, dry season with heavy dust accumulation followed by moisture, insulators having a higher flash-over than given in table 30 or other equally effective means of increasing insulation shall be used. The increase is to be determined by local conditions and experience.

277. PROTECTION AGAINST ARCING.

In installing the insulators and conductors, such precautions as are sanctioned by good modern practice shall be taken to prevent, as far as possible, any arc from forming or to prevent any arc which might be formed from injuring or burning any parts of the supporting structures, insulators or conductors which might render the conductors liable to fall.

278. COMPLIANCE WITH RULE 277 AT CROSSINGS.

Construction in accordance with any one of the methods (A to G) given below will be considered as a means of meeting the requirements of rule 277 above, provided that insulators having a flash-over not less than required by rule 276, C, 1 or C, 2 are used, and in no case having a lower flash-over than insulators generally used in adjacent sections of the line.

Exception: If the insulator hardware on the structure is grounded at crossings and is not grounded on the adjacent parts of the line, construction in accordance with A or B below should be followed, or other equally effective means employed.

The use of grounded construction at crossings only should in general be avoided.

A. The use of a protective device such as a gap, protector tube, lightning arrester, or the like, on or adjacent to the insulator, which is effective in suppressing the power arc or in holding it clear of the insulator, conductor, supporting structure, and hardware.

B. The use of protective gaps or other voltage-limiting devices on structures adjacent to crossing structures, if such devices limit the voltage to not more than 80 percent of the flash-over value of the insulators on the crossing structures.

C. The use of circuit protection by fast-clearing fuses or circuit-breakers. Fuses, or breakers in combination with their relays, shall be considered "fast-clearing" if they interrupt fault currents within one-fifth second (12 cycles at 60 cycles per second).

278. Compliance With Rule 277 at Crossings—Continued.

D. The use of one or more overhead ground wires installed at a higher level than the phase wires on not less than five consecutive spans, including two adjacent spans on each side of the crossing span, provided the ground wire is effectively grounded at structures adjacent to crossing structures.

Such overhead ground wires shall not be grounded at crossing structures unless such structures are inherently grounded or unless the ground wires are grounded at each of the two supporting structures on both sides of and adjacent to the crossing structures. In this latter case the down leads from the overhead ground wires shall be suitably offset from the crossing structures or otherwise arranged so as not to appreciably increase the probability of lightning flash-over from the overhead ground wire and its connections to the phase wires and other current-carrying parts.

E. The use of insulators with ungrounded pins or supporting insulator attachments carried on wood arms.

F. The use of insulators having a flash-over 25 percent greater than those employed on adjacent sections of the line, but not less than 25 percent greater than the values in table 30.

G. If the insulator supports on the crossing structure and on adjacent sections of the line are grounded, the use of insulator strings with higher flash-over voltage at crossing supports than on the adjacent sections, as follows:

(1) If the adjacent parts of the line have five or less units—one extra unit at the crossing.

(2) If the adjacent parts of the line have six or more units—two extra units at the crossing.

(3) Insulation equivalent to that provided by (1) or (2).

SEC. 28. MISCELLANEOUS REQUIREMENTS

280. Supporting Structures for overhead lines.

A. Poles and Towers.

1. RUBBISH.

Poles and towers shall be placed, guarded, and maintained so as to be exposed as little as practicable to brush, grass, rubbish, or building fires.

2. GUARDING POLES.

(*a*) Protection Against Mechanical Injury. Where poles and towers are exposed to abrasion by traffic or to other damage which would materially affect their strength, they shall be protected by guards.

(b) Protection Against Climbing. On closely latticed poles or towers carrying supply conductors exceeding 300 volts to ground, either guards or warning signs shall be used, except as follows:

Exception 1: Where the right-of-way is completely fenced.

Exception 2: Where the right-of-way is not completely fenced, provided the poles or towers are not adjacent to roads, regularly traveled thoroughfares, or places where people frequently gather, such as schools or public playgrounds.

3. WARNING SIGNS.

(a) On Poles or Towers. For warning signs on poles or towers, see rule 280, A, 2, (b).

(b) On Bridge Fixtures. Structures attached to bridges for the purpose of supporting conductors shall be plainly marked with the name, initials, or trade-mark of the utility responsible for the attachment and, in addition, where the voltage exceeds 750 volts to ground, by the following sign or its equivalent:

"Danger—Do Not Touch."

280. A. Poles and Towers—Continued.

4. GROUNDING METAL POLES.

Metal poles not guarded or isolated shall always be specially grounded where in contact with metal-sheathed cable or the metal cases of equipment operating at voltages exceeding 750 volts to ground.

Metal poles not guarded, isolated, or specially grounded should always be considered as imperfectly grounded and the insulators supporting line conductors as well as the strain insulators in attached span wires should, therefore, have a suitable margin of safety and be maintained with special care to prevent leakage to the pole as far as practicable.

5. POLE STEPS.

(a) METAL STEPS. Steps closer than 6½ feet from the ground or other readily accessible place shall not be placed on poles.

(b) WOOD BLOCKS. One wood block (or on private right-of-way more than one) may be placed on poles carrying communication cables or conductors below supply conductors, but the lowest block is not to be less than 3½ feet from the ground or other readily accessible place. On poles carrying only communication conductors, additional wood blocks may be used.

6. IDENTIFICATION OF POLES.

Poles, towers and other supporting structures on which are maintained electric conductors shall be so constructed, located, marked, or numbered as to facilitate identification by employees authorized to work thereon. Date of installation of such structures shall be recorded where practicable by the owner.

280. A. Poles and Towers—Continued.

7. OBSTRUCTIONS.

All poles should be kept free from posters, bills, tacks, nails, growing vines, and other unnecessary obstructions, such as through bolts not properly trimmed.

B. Crossarms.

1. LOCATION.

In general, crossarms should be maintained at right angles to the axis of the pole and to the direction of the attached conductors, and at crossings should be attached to that face of the structure away from the crossing, unless special bracing or double crossarms are used.

Note: Double crossarms are generally used at crossings, unbalanced corners, and dead-ends in order to permit conductor fastenings at two insulators and so prevent slipping, although single crossarms might provide sufficient strength. To secure extra strength, double crossarms are frequently used and crossarm guys are sometimes used.

2. BRACING.

Crossarms shall be securely supported, by bracing if necessary, so as to support safely loads to which they may be subjected, including linemen working on them. Any crossarm or buckarm, except the top one, shall be capable of supporting a vertical load of 225 pounds at either extremity in addition to the weight of the conductors.

C. Unusual Conductor Supports.

Where conductors are attached to structures other than those used solely or principally for supporting the lines, all rules shall be complied with as far as they apply and such additional precautions as may be deemed necessary by the administrative authority shall be taken to avoid injury to such structures or to the person using them. The supporting of conductors on trees and roofs should be avoided where practicable.

281. TREE TRIMMING.

A. General.

Where trees exist near supply-line conductors, they shall be trimmed, if practicable, so that neither the movement of the trees nor the swinging or increased sagging of conductors in wind or ice storms or at high temperatures will bring about contact between the conductors and the trees.

Exception: For the lower-voltage conductors, where trimming is difficult, the conductor may be protected against abrasion and against grounding through the tree by interposing between it and the tree a sufficiently nonabsorptive and substantial insulating material or device.

B. At Wire Crossings and Railroad Crossings.

The crossing span and the next adjoining spans shall be kept free, as far as practicable, from overhanging or decayed trees which might fall into the line.

282. GUYING.

A. Where Used.

When the loads to be imposed on poles, towers, or other supporting structures are greater than can be safely supported by the poles or towers alone, additional strength shall be provided by the use of guys, braces or other suitable construction.

Guys shall be used also, where necessary, whereever conductor tensions are not balanced, as at corners, angles, dead-ends, and changes of grade of construction.

Note: This is to prevent undue increase of sags in adjacent spans as well as to provide sufficient strength for those supports on which the loads are considerably unbalanced.

B. Strength.

The strength of the guy shall meet the requirements of section 26 for the grade of construction that applies.

When guys are used with wood or other poles or

282. B. Strength—Continued.

towers capable of considerable deflection before failure, the guys shall be able to support the entire load in the direction in which they act, the pole acting simply as a strut.

C. Point of Attachment.

The guy should be attached to the structure as near as practicable to the center of the conductor load to be sustained, but for voltages exceeding 8,700 volts between conductors, the insulation afforded by wood crossarms and poles should not be reduced any more than is necessary.

D. Guy Fastenings.

Guys should be stranded and where attached to anchor rods should be protected by suitable guy thimbles or their equivalent. Cedar and other softwood poles around which any guy having a strength of 10,000 pounds or more is wrapped should be protected by the use of suitable guy shims and, where there is a tendency for the guy to slip off the shim, guy hooks or other suitable means of preventing this action should be used. Shims are not necessary in the case of supplementary guys, such as storm guys.

E. Guy Guards.

The ground end of all guys attached to ground anchors exposed to traffic shall be provided with a substantial and conspicuous wood or metal guard not less than 8 feet long.

Recommendation: It is recommended that in exposed or poorly lighted locations such guards be painted white or some other conspicuous color.

F. Insulating Guys from Metal Poles.

Where anchors would otherwise be subject to electrolysis, guys attached to metal poles or structures and not containing guy insulators should be insulated from the metal pole or structure by suitable blocking.

282. Guying—Continued.

G. Anchor Rods.

Anchor rods shall be installed so as to be in line with the pull of the attached guy when under load, except in rock or concrete. The anchor rod shall have an ultimate strength in the eye and shank equal to that required of the guy.

H. Grounding.

The anchored end of guys attached to wood poles carrying circuits of more than 15,000 volts shall be effectively grounded (see section 9 for method) wherever this part of the guy has a clearance of less than 8 feet to ground.

Exception 1: This does not apply to guys in rural districts.

Exception 2: This does not apply if the guy contains an insulator which will meet the requirements of rule 283, A, 2 for the highest voltage liable to be impressed on it.

283. Insulators in Guys Attached to Poles and Towers.

A. Properties of Guy Insulators.

1. MATERIAL.

(a) Grade B. Guy insulators shall be made by the wet-porcelain process or a process equally suitable as regards electrical and mechanical properties.

(b) Grades C, D, and N. No requirements are made for material.

2. ELECTRICAL STRENGTH.

Guy insulators shall have a dry flash-over voltage at least double the normal line voltage and a wet flash-over voltage at least as high as the normal line voltage between conductors.

3. MECHANICAL STRENGTH.

Guy insulators shall have a mechanical strength at least equal to that required of the guys in which they are installed.

283. Insulators in Guys Attached to Poles and Towers—Continued.

B. Use of Guy Insulators.

1. ONE INSULATOR.

An insulator shall be located in each guy which is attached to a pole or structure carrying any supply conductors of more than 300 volts to ground and not more than 15,000 volts between conductors, or in any guy which is exposed to such voltages. This guy insulator shall be located at least 8 feet above the ground.

Exception 1: A guy insulator is not required where the guy is grounded under the conditions set forth in 4 following.

Exception 2: A guy insulator is not required if the guy is attached to a pole on private right-of-way carrying no supply circuits whose voltage exceeds 550 volts or whose transmitted power exceeds 3,200 watts.

Exception 3: A guy insulator is not required if all supply conductors are in a cable having a grounded metal sheath or supported by a grounded messenger.

2. TWO INSULATORS.

Where a guy attached to any pole carrying communication or supply conductors or both, is carried over or under any overhead supply conductor of more than 300 volts to ground and where hazard would otherwise exist, two or more guy insulators shall be placed so as to include the exposed section of the guy between them as far as possible. Neither insulator shall be within 8 feet of the ground.

Exception: These insulators are not required where the guy is grounded under the conditions set forth in 4 following.

283. B. Use of Guy Insulators—Continued.

3. RELATIVE LOCATION OF INSULATORS IN GUYS LOCATED ONE ABOVE THE OTHER.

Where guys in which it is necessary to install insulators are so arranged that one crosses or is above another, insulators shall be so placed that in case any guy sags down upon another the insulators will not become ineffective.

4. GROUNDING OF GUYS.

Insulators are not required in guys under the following conditions:

(a) Where the guy is electrically connected to grounded steel structures or to a ground connection on wood poles.

(b) Where the guys are uniformly effectively grounded throughout any system of overhead lines.

(c) Where the guys are connected to a line conductor which has at least four ground connections in each mile of line in addition to the ground connections at individual services.

284. SPAN-WIRE INSULATORS.

A. Mechanical Strength.

Span-wire insulators shall have a mechanical strength at least equal to that required of the span wire in which they are installed.

B. Use of Span-Wire Insulators.

All span wires, including bracket span wires, shall have a suitable strain insulator (in addition to an insulated hanger if used) inserted between each point of support of the span wire and the lamp or trolley-contact conductor supported, except that single insulation, as provided by an insulated hanger, may be permitted when the span wire or bracket is supported on wood poles supporting only trolley, railway feeder, or communication conductors used in the operation of the railway con-

284. B. Use of Span-Wire Insulators—Continued.

cerned. In case insulated hangers are not used, the strain insulator shall be located so that in the event of a broken span wire the energized part of the span wire cannot be reached from the ground.

Exception: This rule does not apply to insulated feeder taps used as span wires.

285. OVERHEAD CONDUCTORS.

A. Identification.

All conductors of electric-supply and communication lines should be arranged to occupy definite positions throughout, as far as practicable, or shall be constructed, located, marked, numbered, or attached to distinctive insulators or crossarms, so as to facilitate identification by employees authorized to work thereon. This does not prohibit systematic transposition of conductors.

B. Branch Connections.

1. ACCESSIBILITY.

Connections of branches to supply circuits, service loops, and equipment in overhead construction shall be readily accessible to authorized employees. When possible, connections shall be made at poles or other structures.

2. CLEARANCE.

Branch connections shall be supported and placed so that swinging or sagging cannot bring them in contact with other conductors or interfere with the safe use of pole steps, or reduce the climbing or lateral working space.

C. Common Neutral.

Primary and secondary circuits may utilize a single conductor as a common neutral if such conductor has at least four ground connections in each mile of line. Ground connections at individual services are to be counted only if made to underground water piping systems.

286. EQUIPMENT ON POLES.

A. Identification.

All equipment of electric-supply and communication lines should be arranged to occupy definite positions throughout, as far as practicable, or shall be constructed, located, marked, or numbered so as to facilitate identification by employees authorized to work thereon.

B. Location.

Transformers, regulators, lightning arresters, and switches, when located below conductors or other attachments, shall be mounted outside of the climbing space.

C. Guarding.

Current-carrying parts of switches, automatic circuit-breakers, and lightning arresters shall be suitably inclosed or guarded if all the following conditions apply:

1. If of more than 300 volts to ground, and,
2. If located on the climbing side of the pole less than 20 inches from the pole center, and,
3. If located below the top crossarm.

D. Hand Clearance.

All current-carrying parts of switches, fuses, lightning arresters, also transformer connections and other connections which may require operation or adjustment while alive and are exposed at such times, shall be arranged so that in their adjustment while alive the hand need not be brought nearer to any other current-carrying part at a different voltage than the clearances from pole surfaces required in table 9, rule 235, A, 3, (a), for conductors of corresponding voltages. (See also rule 422, A, B, and C, part 4 of this code, for clearances from live parts.)

286. Equipment on Poles—Continued.

E. Street-Lighting Equipment.

1. CLEARANCES FROM POLE SURFACE.

All exposed metal parts of lamps and their supports (unless effectively insulated from the current-carrying parts) shall be maintained at the following distances from the surface of wood poles:

	Inches
In general	20
If located on the side of the pole opposite the designated climbing side	5

Exception: This does not apply where lamps are located at pole tops.

2. CLEARANCES ABOVE GROUND.

Street lamps shall be mounted at not less than the following heights above ground:

	Feet
Over walkways	10
Over roadways:	
Connected to circuits of 150 volts or less	14
Connected to circuits of more than 150 volts	15

3. HORIZONTAL CLEARANCE.

Arc and incandescent lamps in series circuits should have at least 3 feet horizontal clearance from windows, porches, and other spaces accessible to the general public.

4. MATERIAL OF SUSPENSION.

The lowering rope or chain for lighting units arranged to be lowered for examination or maintenance shall be of a material and strength designed to withstand climatic conditions and to sustain the lighting unit safely. The lowering rope or chain, its supports, and fastenings shall be examined periodically.

286. E. Street-Lighting Equipment—Continued.

5. INSULATORS IN SUSPENSION ROPES.

Effective insulators, as specified in rule 283, A, should be inserted at least 8 feet from the ground in metallic suspension ropes or chains supporting lighting units of series circuits.

6. ARC-LAMP DISCONNECTORS.

A suitable device shall be provided by which each arc-lighting unit on series circuits of more than 300 volts to ground may be safely and entirely disconnected from the circuit before the lamp is handled, unless the lamps are always worked on from suitable insulating stools, platforms, or tower wagons, or handled with suitable insulating tools, and treated as under full voltage of the circuit concerned.

7. GROUNDING LAMP POSTS.

Metal lamp posts shall be effectively grounded.

F. Transformers.

Transformers mounted on arms or poles on public thoroughfares shall be at a height above ground not less than 10 feet where over walkways and not less than 15 feet where over roadways.

Exception: Where it is the established practice to mount transformers at lesser distances above ground, such practice may be continued if the reduced mounting heights are carefully maintained.

287. PROTECTION FOR EXPOSED OVERHEAD COMMUNICATION LINES.

A. Open Wire.

Communication lines for public use and fire-alarm lines shall be treated as follows, if at any point they are exposed to supply (including trolley) lines of more than 400 volts to ground:

1. At stations for public use they shall be protected by one of the methods specified in part 3, section 39 of this code.

287. A. Open Wire—Continued.

2. Elsewhere they shall be isolated by elevation or otherwise guarded so as to be inaccessible to the public.

B. Metal-Sheathed Cable.

Metal-sheathed cables and messengers shall be isolated or grounded in conformity with the general requirements of section 21.

288. CIRCUITS OF ONE CLASS USED EXCLUSIVELY IN THE OPERATION OF CIRCUITS OF ANOTHER CLASS.

A. Overhead Communication Circuits Used Exclusively in the Operation of Supply Circuits.

1. CHOICE OF METHOD.

Communication circuits used exclusively in the operation of supply lines may be run either as ordinary communication circuits or as supply circuits under the conditions specified in 3 and 4 of this rule, respectively. After selection of the type of communication-circuit construction and protection for any section which is isolated, or is separated by transformers, such construction and protection shall be consistently adhered to throughout the extent of such isolated section of the communication system.

2. GUARDING.

Communication circuits used in the operation of supply lines shall be isolated by elevation or otherwise guarded at all points so as to be inaccessible to the public.

3. WHERE ORDINARY COMMUNICATION-LINE CONSTRUCTION MAY BE USED.

Communication circuits used in the operation of supply lines may be run as ordinary communication conductors under the following conditions:

(a) Where such circuits are below supply conductors in the operation of which they are used (including high-voltage trolley feeders)

288. A. Overhead Communication Circuits Used Exclusively in the Operation of Supply Circuits—Continued.

at crossings, conflicts, or on commonly used poles, provided:

(1) Such communication circuits occupy a position below all other conductors or equipment at crossings, conflicts, or on commonly used poles.

(2) Such communication circuits and their connected equipment are adequately guarded and are accessible only to authorized persons.

(3) The precautions in part 3, section 39, and part 4, section 44 of this code, have been taken.

(b) Where such circuits are below supply conductors in the operation of which they are used and are above other supply or communication conductors at wire crossings, conflicts, or on the same poles, provided the communication circuits are protected by fuseless lightning arresters, drainage coils, or other suitable devices to prevent the communication circuit voltage from normally exceeding 400 volts to ground.

Note: The grades of construction for communication conductors with inverted levels apply.

4. WHERE SUPPLY-LINE CONSTRUCTION MUST BE USED.

Communication circuits used in the operation of supply lines shall comply with all requirements for the supply lines with which they are used, where they do not comply with the provisos of 3 (a) or (b) above.

Exception 1: If the voltage of the supply conductors concerned exceeds 8,700 volts between conductors, the communication conductors, need only meet the requirements for supply

288. A. Overhead Communication Circuits Used Exclusively in the Operation of Supply Circuits—Continued.

conductors of 5,000 to 8,700 volts between conductors.

Exception 2: Where the supply conductors are required to meet grade C, the size of the communication conductors may be the same as for grade D (see rule 262, I, 2) for spans up to 150 feet.

B. Supply Circuits Used Exclusively in the Operation of Communication Circuits. (See also sec. 29.)

Circuits used for supplying power solely to apparatus forming part of a communication system may be run either in open wire or in aerial or underground cable as follows:

1. WHERE RUN IN OPEN WIRE, such circuits shall have the grades of construction, clearances, insulation, etc., prescribed elsewhere in part 2 for supply or communication circuits of the voltage concerned.
2. WHERE RUN IN AERIAL OR UNDERGROUND CABLE and the following requirements are met, the grades of construction, clearances, separations, locations, etc., prescribed elsewhere in part 2 for communication cables shall apply:
   (a) Such cables are covered with effectively grounded continuous metal sheaths or are carried in metal cable rings on effectively grounded messengers.
   (b) All circuits in such cables are owned or operated by one party and are maintained only by qualified employees.
   (c) Supply circuits included in such cables are terminated at points accessible only to qualified employees.
   (d) Communication circuits brought out of such a cable, if they do not terminate in a repeater station or terminal office, shall be so protected or arranged that in the event of a

288. B. Supply Circuits Used Exclusively in the Operation of Communication Circuits—Continued.

failure within the cable, the voltage on these communication circuits will not exceed 400 volts to ground.

(e) Terminal apparatus for the power supply shall be arranged so that live parts are inaccessible when such supply circuits are energized.

Exception: The provisions of B, 1 and 2 above, do not apply to supply circuits of 550 volts or less and which carry power not in excess of 3,200 watts, covered in rule 220, B, 3.

289. OVERHEAD ELECTRIC RAILWAY CONSTRUCTION.

A. Trolley-Contact Conductor Supports.

All overhead trolley-contact conductors shall be supported and arranged so that the breaking of a single contact conductor fastening will not allow the trolley conductor, live span wire, or current-carrying connection to come within 10 feet (measured vertically) from the ground, or from any platform accessible to the general public.

Span-wire insulation for trolley-contact conductors shall comply with rule 284.

B. High-Voltage Contact Conductors.

Every trolley-contact conductor of more than 750 volts in urban districts where not on fenced right-of-way shall be suspended so as to minimize the liability of a break and, as far as practicable, so that if broken at a single point, it can not fall within 12 feet (measured vertically) from the ground or any platform accessible to the general public.

C. Third Rails.

Third rails shall be protected where not on fenced rights-of-way by adequate guards composed of wood or other suitable material.

289. Overhead Electric Railway Construction—Continued.

D. Prevention of Loss of Contact at Railroad Crossings.

Trolley-contact conductors shall be arranged as set forth in either 1 or 2 following, at grade crossings with interurban or other heavy-duty or high-speed railroad systems:

1. The trolley-contact conductor shall be provided with live trolley guards of suitable construction, or,
2. The trolley-contact conductor shall be as far as practicable at the same height above its own track throughout the crossing span and the next adjoining spans. Where a uniform height above rail is not adhered to, the change shall be made in a very gradual manner. Where the crossing span exceeds 100 feet, catenary construction shall be used.

Exception: This rule does not apply where the system is protected by interlocking derails or by gates.

E. Guards Under Bridges.

1. WHERE GUARDING IS REQUIRED.

Guarding is required where the trolley-contact conductor is so located that a trolley pole leaving the conductor can make simultaneous contact between it and the bridge structure.

2. NATURE OF GUARDING.

Guarding shall consist of a substantial inverted trough of nonconducting material located above the contact conductor, or other suitable means of preventing contact between the trolley pole and the bridge structure.

SEC. 29. RULES FOR UNDERGROUND LINES

(See also rule 288, B, 2.)

290. LOCATION.

A. General Location.

Underground systems of electric conductors should be located so as to be subject to the least practicable disturbance. Railway tracks and underground structures, including catch basins, gas pipes, etc., should be avoided where practicable.

B. Ducts.

The ducts between adjacent manholes or other outlets should be laid as straight and direct as practicable.

C. Manholes.

Manhole openings, where practicable, shall be located so as to provide safe and convenient access. At crossings under railroads, the manholes, pull boxes, and terminals should, where practicable, be located away from the roadbed.

291. CONSTRUCTION OF DUCT AND CABLE SYSTEMS.

A. Material, Size, and Finish of Ducts.

Ducts shall be of such material, size, mechanical strength, and finish as to facilitate the installation and maintenance of conductors or cables. Ducts shall be freed from burrs before laying and shall have clear bores.

B. Grading of Ducts.

Where it is necessary to drain ducts the grade of the ducts shall be such as to permit proper and adequate drainage.

C. Settling.

Ducts should be suitably reinforced or be laid on suitable foundations of sufficient mechanical strength where necessary to protect them from settling.

291. Construction of Duct and Cable Systems—Continued.

D. Clearances.

1. GENERAL.

The clearance between duct or cable systems and other underground structures paralleling them, shall be as great as practicable. The distance between the top covering of the system and the pavement surface, or other surface under which the system is constructed, shall be sufficient to protect the system from injury by traffic.

2. BELOW BASE OF RAIL.

The top of all duct and cable system structures, except as hereafter specified, shall generally be located at a depth of not less than 30 inches, in the case of street railways, and not less than 42 inches, in the case of steam and electric railroads, below the base of rail. Where unusual conditions exist or where proposed construction would interfere with existing construction, a greater depth than specified above may be required.

Exception 1: Where this is impracticable, or for other reasons, this clearance may be reduced by agreement between the parties concerned. In no case, however, shall the top of the conduit protection extend higher than the bottom of the ballast section which is subject to working or cleaning.

Exception 2: Where physical and chemical conditions will permit, a conduit consisting of not more than two iron pipes, not exceeding 4 inches in diameter, or two creosoted wood ducts not exceeding 6 inches square, or one or more cables of a type designed for burying directly in the earth used for communication lines, or for service supply circuits not exceeding 750 volts, may be laid in the ground beneath railroad tracks without any form of

291. D. Clearances—Continued.

protection at a minimum depth of 18 inches below the base of the rail unless the worked ballast section of the roadbed exceeds 18 inches, in which case the conduit shall be laid below the ballast section.

3. IRON PIPE CONDUIT.

Where iron pipe is used as a conduit for underground cables or conductors, it shall not be laid in contact with water, gas, or steam metallic-pipe systems. Where the clearance is less than two inches, the metal conduit shall be adequately separated from other metallic-pipe systems by a barrier of suitable materials, or they shall be electrically bonded together at the point of least separation.

E. Separations Between Supply and Communication Duct Systems.

1. GENERAL.

Duct systems, including laterals, to be occupied by communication conductors for public use should be separated, where practicable, from duct systems, including laterals, for supply conductors by not less than 3 inches of concrete, 4 inches of brick masonry, or 12 inches of well-tamped earth.

Exception 1: Extensions may, however, be made to existing interconnected or jointly owned and jointly occupied duct systems used in common by municipalities, communication companies, or supply companies with less effective separations than above specified.

Exception 2: Cables containing circuits of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts, used exclusively in connection with the operation of a railway signal or supply system, may be carried in the same

291. E. Separations Between Supply and Communication Duct Systems—Continued.

duct system with communication cables, if such construction is agreed to by all parties concerned, and where the communication cables are exclusively used for the operation of the railway signal or supply system, they may be carried in the same duct.

2. ENTERING MANHOLES.

Where communication and supply conductors or cables occupy ducts terminating in the same manhole, the two classes of ducts should be separated as widely as practicable and where practicable should enter the manhole from opposite sides.

Note: This requirement is made so that cables can be racked along side walls with a minimum of crosses between the two classes of conductors.

F. Duct Entrances Into Manholes.

Iron-pipe conduit terminating in manholes, handholes, or other permanent openings of underground systems, shall be provided with an effective shield, bushing or other smooth outlet.

Exception: This does not apply to communication conductors, to supply conductors of less than 300 volts between conductors, or to armored cables of any voltage.

G. Sealing Laterals.

Lateral ducts for service connections to buildings, through which gas or water may enter buildings or other duct systems, should be effectively plugged or cemented by the use of asphaltum, pitch, or other suitable means.

H. Duct Arrangement for Dissipation of Heat.

Duct systems intended to carry supply cables of large current capacity should be arranged, where practicable, so that ducts carrying such cables will not dissipate their heat solely through other ducts.

292. CONSTRUCTION OF MANHOLES.

A. Minimum Strength.

The design and construction of manholes and handholes shall provide sufficient strength to sustain, with a suitable margin of safety, the loads which may reasonably be imposed on them.

B. Dimensions.

Manholes should meet the following requirements where practicable:

1. WIDTH.

   The least horizontal inside dimension should be not less than 3 feet 6 inches.

2. WORKING SPACE.

   A clear working space should be provided. The horizontal dimension should be not less than 3 feet. The vertical dimension should be not less than 6 feet except in manholes where the opening is within 1 foot on each side of the full size of the manhole.

   Exception: The dimensions specified in 1 and 2 above are not necessary in service boxes, handholes, or in manholes serving a small number of ducts, or in manholes used exclusively for communication-system equipment and cables.

C. Drainage.

Where drainage is into sewers, suitable traps shall be provided to prevent entrance of sewer gas into manholes.

D. Ventilation.

Adequate ventilation to open air shall be provided for manholes from which any openings exist into subways entered by the public. Where such manholes house transformers, sectionalizing switches, or regulators, etc., the ventilator ducts shall be cleaned at necessary intervals.

Exception: Subways under water or in other locations where it is impracticable to comply.

292. Construction of Manholes—Continued.

E. Manhole Openings.

Round openings to any manhole should be not less than 24 inches in diameter. Rectangular openings should have dimensions not less than 24 by 20 inches.

Exception: The dimensions specified above are not necessary in service boxes and handholes or in manholes serving a small number of ducts.

F. Manhole Covers.

Manholes and handholes, while not being worked in, shall be securely closed by covers of sufficient strength to sustain such loads as may reasonably be imposed upon them.

G. Supports for Cables.

Cables should be adequately supported at each manhole.

H. Manhole Location.

Manhole openings shall, where practicable, be located so that barriers or other suitable guards can be placed to protect the opening effectively when uncovered.

293. LOCATION OF CABLES.

A. Accessibility.

Cables in manholes shall be reasonably accessible to workmen and clear working space shall be maintained at all times.

B. Cables Carrying Large Currents.

Cables intended to carry large currents should be located, where practicable, in outside ducts so that they will not necessarily dissipate heat solely through adjacent ducts.

C. Separation Between Conductors.

1. CABLES OF DIFFERENT VOLTAGES.

Cables shall be arranged and supported in ducts and manholes so that those operating at higher

293. C. Separation Between Conductors—Continued.

voltages will be separated as far as practicable from those operating at lower voltages.

2. CABLES OF DIFFERENT SYSTEMS.

Cables belonging to different systems, particularly supply-distribution and communication systems, shall not be installed in the same duct.

Exception: This does not apply to the installation of railway-signal supply and communication cables in the same duct, as permitted by exception 2 in rule 291, E, 1.

3. CABLES OF SUPPLY AND COMMUNICATION SYSTEMS.

(a) GENERAL. Supply cables and communication cables for public use should, in general, be maintained in separate duct systems, and particularly in separate manholes.

Exception 1: Cable extensions may be made to existing interconnected or jointly owned and jointly occupied duct systems used in common by municipalities, communication companies, or supply companies.

Exception 2: This does not apply where railway-signal supply and communication cables are carried in the same duct system as permitted in exception 2, rule 291, E, 1.

(b) IN THE SAME MANHOLE. Supply cables and communication cables for public use occupying the same manhole should, where practicable, be maintained at opposite sides of the manhole.

Where supply and communication cables must cross, a separation of at least 1 foot shall, where practicable, be maintained.

294. PROTECTION AND SEPARATION OF CONDUCTORS BURIED IN EARTH.

A. Separation.

The separation between buried communication and buried supply conductors or cables shall consist of not less than 12 inches of well tamped earth, 4 inches of brick, or 3 inches of concrete.

Exception: This separation and protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

B. Protection at Crossings of Cables.

At all crossings where buried supply conductors or cables are above communication conductors or cables, the supply conductors or cables shall be protected from digging operations by concrete or creosoted wood plank or equivalent mechanical protective covering extending at least 2 feet in each direction from the point of crossing.

Exception: This separation and protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

C. Protection of Cables Installed Parallel.

Where buried communication and buried supply conductors or cables are installed in the same trench generally parallel to each other, the buried supply conductors or cables shall be covered with

294. C. Protection of Cables Installed Parallel—Continued.

concrete or creosoted wood plank or equivalent mechanical protection, except that this covering may be omitted in the following cases:

1. Where the voltage of the supply conductors does not exceed 300 volts to ground.
2. Where the supply conductors or cables are encased in a continuous metallic sheath effectively grounded.
3. Where the supply conductors or cables are installed more than 2 feet horizontally from communication conductors.

Exception: This separation and protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

295. PROTECTION OF CONDUCTORS IN DUCT SYSTEMS AND MANHOLES.

A. Protection Against Arcing.

A suitable fire-resistant covering should be placed on the following cables to prevent injury from arcing:

1. Closely grouped lead-sheathed supply cables containing circuits of more than 8,700 volts, or of large current capacity operating at more than 750 volts ac or 300 volts dc.
2. Communication cables and supply cables of large current capacity, if occupying the same side of the manhole, or if they cross each other.

B. Bonding.

Exposed metallic cable sheaths shall be bonded at suitable intervals with a conductor of suitable size, electrolysis conditions permitting. Supply cable sheaths need not be bonded to communication cable sheaths.

296. GUARDING OF LIVE PARTS IN MANHOLES.

A. Conductor Joints or Terminals.

Joints or terminals of conductors or cables of supply systems shall be arranged so that there are no bare ungrounded current-carrying metal parts exposed to accidental contact within manholes or handholes.

B. Apparatus.

Live parts of protective, control or other apparatus installed and maintained in manholes should be enclosed in suitable grounded cases or in cases having no exposed metallic parts.

297. CONSTRUCTION AT RISERS FROM UNDERGROUND.

A. Separation Between Risers of Communication and Supply Systems.

The placing of risers for communication systems and risers for supply systems on the same pole should be avoided where practicable. If it is necessary to use the same pole for the risers of both systems, they shall be placed on opposite semicircumferences of the pole where practicable. Where located on streets or highways, risers should, where practicable, be placed on poles so as to be in the safest available location from the point of view of traffic damage.

B. Mechanical Protection of Conductors.

All supply conductors or cables from underground systems which connect to overhead systems shall be protected by a covering which gives suitable mechanical protection up to a point 8 feet above the ground.

Exception: Armored cables or cables installed in a grounded metal conduit.

C. Grounding of Riser Pipes.

Exposed metal riser pipes containing supply conductors shall be grounded unless such conductors are covered with a grounded metal sheath or are themselves grounded.

297. Construction at Risers from Underground—Continued.

D. Conductor Terminal Construction.

The terminals of underground cables operating at more than 750 volts to ground and connecting to overhead open-wire systems shall meet the following requirements:

1. PROTECTION AGAINST MOISTURE.

Protection shall be provided so that moisture will not enter the cable.

2. INSULATION OF CONDUCTORS.

Conductors shall be properly insulated from the grounded metal sheath. In addition, the conductors of multiple-conductor cable shall be properly separated and insulated from each other.

Note: These requirements may be fulfilled by the use of potheads or other equivalent devices, such as oil switches, if incidentally they accomplish the same purpose.

E. Clearance Above Ground for Open Supply Wiring.

For supply wires connecting to underground systems see rule 232, C.

298. IDENTIFICATION OF CONDUCTORS.

Cables shall be permanently identified by tags or otherwise at each manhole or other permanent opening of the underground system. Where the duct formation on opposite sides of the manhole is the same, the cables where practicable should be installed in corresponding ducts.

Exception: This requirement does not apply where the position of a cable, in conjunction with diagrams supplied to workmen, gives sufficient identification, or where the manhole is occupied solely by the communication cables of one utility, or of two utility companies agreeing thereto.

299. IDENTIFICATION OF APPARATUS CONNECTED IN MULTIPLE.

Where transformers, regulators, or other similar apparatus not located in the same manhole operate in multiple, special tags, diagrams, or other suitable means shall be used to indicate that fact.

Exception: This requirement does not apply where disconnecting devices are provided to permit cutting such equipment completely off the system.

PART 3. RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRIC UTILIZATION EQUIPMENT

CONTENTS

Page

Sec. 30. Scope of rules and general requirements 247
300. Scope of the rules 247
301. Application of the rules 248
302. General requirements 248
303. Reference to other codes 249
304. Grounding 249
305. Working spaces about electric equipment 252
306. Guarding or isolating live parts 253
307. Hazardous locations 254
308. Protection by disconnection 254
309. Identification of equipment 255
Sec. 31. Conductors 255
310. Electrical protection 255
311. Protective covering 257
312. Identification of conductors and terminals 257
313. Guarding and isolating conductors 260
314. Guarding in damp or hazardous locations 260
315. Precautions against excessive inductance and eddy currents 260
316. Splicing and taping 261
317. Uninsulated conductors 261
Sec. 32. Fuses, circuit-breakers, switches, and controllers 261
320. General requirements for switches 261
321. Hazardous locations 263
322. Where switches are required 263
323. Character of switches and disconnectors 266
324. Disconnection of fuses and thermal cut-outs before handling 267
325. Arcing or suddenly moving parts 269
326. Grounding non-current-carrying metal parts 269
327. Guarding live parts 269
328. Inclosed air-break switches (not including snap switches) 270
329. Control equipment 271

Page

Sec. 33. Switchboards and panelboards — 277
330. Accessibility and convenient attendance — 277
331. Location and illumination — 277
332. Arrangement and identification — 277
333. Spacings, barriers, and covers — 278
334. Grounding frames — 278
335. Guarding current-carrying parts — 278
336. Fuses on switchboards — 279
337. Panelboards — 280

Sec. 34. Motors and motor-driven machinery — 281
340. Control devices — 281
341. Hazardous locations — 282
342. Deteriorating agencies — 282
343. Guards for live parts — 283
344. Grounding machine frames — 283
345. Protecting moving parts — 284

Sec. 35. Electric furnaces, storage batteries, transformers, and lightning arresters — 284
350. Protection from burns — 284
351. Grounding of furnace frames — 284
352. Guarding live parts — 285
353. Storage batteries — 285
354. Transformers — 285
355. Lightning arresters — 285

Sec. 36. Lighting fixtures and signs — 286
360. Fixtures — 286
361. Receptacle for convenience outlet — 287
362. Exposed live parts — 287
363. Signs — 287
364. Connectors for signs — 288
365. Lamps in series circuits — 288
366. Safe access to arc lamps — 288

Sec. 37. Portable appliances, cables and connectors, and insect eliminators — 289
370. Insulation — 289
371. Grounding of frames — 289
372. Cable connectors — 290
373. Identified conductors, cords, and connectors — 291
374. Use of portables and pendants — 291
375. Portable outdoors equipment of more than 750 volts between conductors — 293
376. Insect eliminators — 294

Sec. 38. Electrically operated industrial locomotives, cars, cranes, hoists, and elevators — 294
380. Guarding live and moving parts — 294
381. Grounding noncurrent-carrying parts — 297
382. Control of energy supply to cars, cranes, and industrial locomotives — 298
383. Control of movement of industrial locomotives, cars, cranes, and elevators — 299
384. Subway and car lighting — 300

Page

Sec. 39. Telephone and other communication apparatus on circuits exposed to supply lines or lightning ------ 300
390. Protective requirements ---------------------- 300
391. Guarding current-carrying parts -------------- 301
392. Grounding ---------------------------------- 302

SEC. 30. SCOPE OF RULES AND GENERAL REQUIREMENTS

300. Scope of the Rules.

A. Voltage Limits and Occupancies.

The following rules apply to electric utilization equipment between 25 and 750 volts, where accessible to other than qualified electrical operators, as in mills, factories, mercantile establishments, hotels, theaters, and other public buildings, cars and other vehicles, dwellings, and similar places. Communication equipment connected to communication lines (see definition) is exempted, except from rules under section 39.

B. Equipment of More Than 750 Volts.

Equipment and conductors of more than 750 volts between conductors where accessible to other than qualified electrical operators, shall (in addition to complying with the rules of part 3 for conductors of more than 300 volts) comply also with the rules for electrical supply stations, part 1, where such rules require more than the rules of part 3. Current-carrying parts shall be either incased in permanently grounded metal cases or conduits, or otherwise suitably guarded to prevent access (or too close approach) to such current-carrying parts by any but qualified persons.

C. Utilization Equipment Regarded as Supply Equipment.

Electric utilization equipment, however, as well as generating equipment, if inclosed in a separate room which is inaccessible to unqualified persons, and if when in service is under the control of a qualified person, may be installed in conformity with the rules applying to electrical supply stations (part 1) and in that case does not come under these rules.

301. APPLICATION OF THE RULES.

A. Waiving of Rules.

The rules are intended to apply to all installations except as modified or waived by the proper administrative authority or its authorized agents. They are intended to be so modified or waived in particular cases wherever any rules are shown for any reason to be impracticable, such as by involving expense not justified by the protection secured, provided equivalent or safer construction is secured in other ways. Distinction is made between the requirements for installations which are accessible only to qualified persons and the requirements for installations accessible to other than qualified persons, as to the relative practicability of adhering closely to the literal requirements of the standard.

B. Intent of Rules.

The intent of the rules, which constitute a minimum standard, will be realized: (1) by applying the rules in full to all new installations, reconstructions, and extensions; (2) by bringing existing installations into conformity with these rules as far as may be directed by the administrative authority, and within the time determined by the administrative authority.

C. Temporary or Emergency Installations.

It will sometimes be necessary to modify or waive certain of the rules in case of temporary or emergency installations or installations which are shortly to be discarded or reconstructed.

302. GENERAL REQUIREMENTS

A. Approved Equipment.

Equipment which has been subjected to examination by some properly qualified body and found to comply with the general requirements of this code, the National Electrical Code, and other nonconflicting accepted standards which apply for any given purpose, should be used; otherwise, the approval of the

302. A. Approved Equipment—Continued.

administrative authority should be obtained in advance.

Note: In order to avoid the necessity for repetition of such examinations by different examiners, frequently with inadequate facilities for such work, and to avoid the confusion which would result from conflicting reports as to the suitability of equipment examined for a given purpose, it is necessary that such examinations should be made under standard conditions, and the record made generally available through promulgation by organizations properly equipped and qualified for experimental testing, inspections of the run of goods at factories, and service-value determinations, through field inspections, and whose findings are subject to appeal to the National Bureau of Standards.

B. Future Inspections.

Electric utilization equipment shall be installed and maintained in conformity with these safety rules. Persons in charge of equipment shall have periodic inspections of equipment and wiring made, and similar inspections shall be made by the supervising authority.

303. REFERENCE TO OTHER CODES.

Reference is made to other related safety codes approved by the American Standards Association, and particularly to the National Electrical Code ASA. C1.

Note: Copies of these codes can be obtained from the American Standards Association, 29 West Thirty-ninth Street, New York, N. Y.

304. GROUNDING.

A. Grounding Method.

Where grounding is required, all grounding of circuits, lightning arresters, equipment, or wire raceways, which is intended to be a permanent and effective protective measure, shall be made in accordance with the methods specified in section 9.

304. Grounding—Continued.

B. Circuits Required to be Grounded.

All circuits included in rule 300, A shall be effectively grounded in accordance with the rules of section 9, except that the following are not required to be grounded:

Exception 1: Circuits on two-wire direct-current systems, provided the system is equipped with a ground detector.

Exception 2: Delta-connected three-phase circuits; except that such circuits when partly used for lighting shall be so arranged and grounded, that the lighting circuits will have the lowest practicable voltage to ground.

Exception 3: Circuits of more than 150 volts to ground.

Note: It is recommended that such circuits be grounded if the voltage to ground of any conductor of the circuit will not exceed 300 volts after grounding.

Exception 4: Electric furnace circuits. (See rule 351.)

Exception 5: Electric crane circuits operating over combustible fibers.

Exception 6: Circuits of less than 50 volts between conductors unless run overhead between buildings, or supplied by transformers operating on circuits of more than 150 volts to ground, or by transformers operating on ungrounded circuits.

C. Grounding Non current-Carrying Metal Parts.

Conductor armor, conductor raceways, and all equipment supplied directly by metal-incased wiring shall be grounded.

Exposed noncurrent-carrying metal parts of other fixed electric utilization equipment (such as frames of motors, cranes, cars, and switchboards, and inclosures of switches and transformers) shall be grounded under any one of the following conditions: (See section 9 for method of grounding, and rule 371 for portable appliances.)

304. C. Grounding Noncurrent carrying Metal Parts—Continued.

1. If operated at more than 150 volts to ground, regardless of location.
2. If located where exposed grounded surfaces, such as metal frames of other machines, plumbing fixtures, conducting floors or walls, exist within reach of persons while touching the metal parts under consideration. (Usually grounded surfaces within 5 feet horizontally of the parts considered and within 8 feet vertically of the floor are considered within reach.)
3. If located where explosives, inflammable gas, or inflammable flyings normally exist in dangerous quantities, regardless of voltage.

Exception 1: Parts of machines, such as name plates, screws in wood, and similar small parts, and metal covers of fuses and switch bases which are thoroughly and effectively insulated, and which are not liable to become alive except under very unusual circumstances are not considered as coming under this rule and may be left ungrounded.

Exception 2: No ground connection need be made to exposed metal frames of switchboards, motors, or lighting fixtures connected to direct-current trolley or third-rail circuits, or where accessible to qualified persons only, provided that such frames are effectively insulated from ground, and provided that the metal frames in question are so located with reference to insulating mats, floors, or platforms that persons cannot readily touch the metal frames in question without standing on such mats, floors, or platforms. (See also rules 329, H, 1 (d) and 344 for further exception.)

304. C. Grounding Noncurrent-Carrying Metal Parts—Continued.

Exception 3: No ground connection need be made to metal inclosures housing interior wiring conductors, provided such inclosures do not exceed 25 feet in length, are insulated from grounded piping or other grounded surfaces and are out of reach from grounded surfaces or guarded against contact by persons.

Exception 4: No ground connection need be made to metal pipe used for the mechanical protection of interior wiring conductors, provided each of the conductors contained are encased in a continuous nonconducting flexible tubing.

305. WORKING SPACES ABOUT ELECTRIC EQUIPMENT.

A. Adequate Space.

Suitable working space shall be provided and maintained about all electric utilization equipment.

B. Dimensions.

The horizontal dimension of the working space in front of live parts shall be not less than:

1. For parts on one side of more than 150 volts to ground and no live or grounded parts on the other side of the working space, 2.5 feet.
2. For parts on one side of more than 150 volts to ground and live or grounded parts on the other, 4 feet.
3. For parts on one side of less than 150 volts to ground and no live or grounded parts on the other, 1.5 feet.
4. For parts on one side of less than 150 volts to ground and live or grounded parts on the other, 2.5 feet.

C. Clear Spaces.

Working spaces adjacent to exposed live parts shall not be used as passageways.

D. Elevation of Equipment.

The elevation of the equipment at least 8 feet above ordinarily accessible working platforms usually affords protection at least equivalent to that provided

305. D. Elevation of Equipment—Continued.

by the horizontal clearances of B and may be used in lieu thereof.

306. GUARDING OR ISOLATING LIVE PARTS.

A. Inclosure or Elevation.

Except as elsewhere required or permitted by this code, all bare, ungrounded live parts of electric utilization equipment, such as bus bars, conductors, and terminals, operating at more than 50 volts to ground, shall be protected by one of the following means:

1. Inclosure, which gives access to live parts only through opening a door or cover.
2. Guarding, as by railing, screen, or barriers which remove the liability of contact or approach.
3. Isolation, by placing at least 8 feet above the floor line, or by removing beyond ready accessibility.

Note: Inclosures may consist of suitable casings or suitable insulating coverings. The continuous insulating covering of conductors should be depended upon only when the circuit is grounded in accordance with section 9 or is less than 300 volts to ground and entirely unexposed to leakage or induction from higher-voltage circuits, and where in addition it is impracticable to install more suitable guards. It should be depended upon then only when the covering is not exposed to liability of mechanical injury, and is very substantial, thoroughly dry, and contains no noninsulating flameproofing compound or oil-soaked rubber. It is recommended that in addition to the protection afforded by such coverings the insulating mats or platforms called for in paragraph B be used.

Where covers, casings, or barriers must at any time be removed from the current-carrying parts which they guard, while these parts are alive, the covers, casings, or barriers, should be of insulating material, or so arranged that they cannot readily be brought in contact with the live parts.

B. Exception Where Mats and Platforms are Used.

Where current-carrying parts of more than 150 volts to ground must necessarily be exposed (unguarded) within 8 feet from the floor, all surrounding conducting floors and other conducting surfaces within reach

306. B. Exception Where Mats and Platforms are Used—Continued.

shall be covered with suitable insulating platforms, mats, or other insulating devices.

Note: Mats may be of wood, held together by wood pins, or of cork matting, linoleum, or rubber. The material and construction should be suitable for the voltage concerned and for the prevailing conditions. If subject to moisture or to accumulation of conducting dust, flyings, or chips, mats should present surfaces minimizing the hazards from these sources.

307. HAZARDOUS LOCATIONS.

A. Where Explosives and Inflammables Exist.

In locations where explosives, inflammable gas, or inflammable flyings normally exist in dangerous quantities, all parts at which high temperature, sparking, or arcing is liable to occur shall be inclosed by one of the following methods:

1. By installing in a separate room or compartment, free from explosive material.
2. By surrounding with an inclosure of nonabsorptive, noncombustible material capable of withstanding without injury and without transmitting flame to the outside any explosion that may occur within.

B. In Wet Places.

External parts of lighting fixtures and all other electric equipment when within eight feet of the floor in wet locations shall be constructed of nonabsorptive insulating materials or, if of metal, shall be grounded as required by rule 304, C.

308. PROTECTION BY DISCONNECTION.

Electric utilization equipment which will require maintenance work upon it shall have approved means of disconnecting it from all ungrounded conductors of its supply circuit.

Note: Every installation has a switch or switches controlling the power supply or subdividing it. These switches may be used as the required disconnecting means where readily accessible, but in many cases it is recommended that additional disconnecting means be provided for convenience and in order not to interfere with other apparatus.

308. Protection by Disconnection—Continued.

1. If the control apparatus opens all the main leads to the motor, and the pilot circuits are fused, a disconnector only is required for connected loads in excess of 50 horsepower.
2. If the control apparatus does not open all of the main leads to the motor, a circuit switch or other approved disconnecting means shall be used.

Note: By main leads to the motor is meant: *dc motors*—all armature circuits (not including shunt-field circuits); *ac motors*—all primary leads (not including the secondary leads of a slip-ring motor or the field circuit of a synchronous motor).

3. The disconnecting means shall make all circuits of the controller and motor dead.
4. If the disconnecting means is equipped for locking in the open position it need not be in sight of the motor.
5. If the starter is not designed for opening the motor circuit, a circuit switch should be provided in the branch circuit of each motor.

309. IDENTIFICATION OF EQUIPMENT.

A. Safety by Identification.

All electric utilization equipment shall be suitably identified when added safety can be obtained thereby. (See also rules 312, 332, and 373.)

Note: The identification may be by location, color, number, name plate, label, design, or other means.

B. Voltage and Use.

The voltage and intended use shall be shown wherever it will reduce the hazard or decrease the liability of error in operation.

SEC. 31. CONDUCTORS

310. ELECTRICAL PROTECTION.

A. Fuses and Circuit-Breakers.

Each conductor (except neutral conductors, grounded conductors, grounding conductors, and conductors of circuits the opening of which may cause special

310. A. Fuses and Circuit-Breakers—Continued.

hazard by the interruption of service or removal of protection) shall be protected against excessive current by a suitable fuse or other automatic circuit-breaking device or by the design of the system.

B. Grounded and Neutral Conductors.

No fuse or other automatic circuit-breaking device shall be placed in any conductor which is required to be grounded, nor in the neutral conductor of a three-wire system, except as follows:

1. SIMULTANEOUS OPENING.

If the automatic circuit-breaking device simultaneously opens all conductors of the circuit.

2. CONDUCTORS OF BRANCH CIRCUITS.

In locations where the conditions of grounding, or the likelihood of reversal of connection warrants, the administrative authority may require, on systems having a grounded neutral or having one side grounded, that the conductors of two-wire branch circuits shall have a fuse or other automatic circuit-breaking device in each conductor.

C. Switches.

Switches shall open all conductors of the circuit by one operation except as follows:

1. The switch need not open a grounded conductor. In the case of service switches, if the switch does not interrupt the grounded conductor, other means shall be provided in the service cabinet or on the switchboard for disconnecting the grounded conductor from the interior wiring.
2. Single-pole switches may be used in two-wire branch circuits; on grounded circuits they shall be placed in the ungrounded conductor.
3. On three-wire systems with a grounded neutral conductor the service switch may open either outside wire independently of the other, provided the neutral cannot be opened without opening both outside wires.

310. C. Switches—Continued.

4. Electric meters and control circuits of time switches may be connected on the supply side of the service switch and fuses or circuit-breaker on alternating-current supply not exceeding 300 volts between conductors, provided no wiring or live parts are exposed and the connections are inaccessible to unauthorized persons.

311. PROTECTIVE COVERING.

A. Mechanical Protection.

Where exposed to mechanical injury, suitable casing, armor, or other means shall be employed to prevent injury or disturbance to conductors, their insulation, or supports.

B. Bare Conductors.

Bare conductors shall be used only for circuits of less than 300 volts to ground where accessible to qualified persons only, or in locations where insulated conductors are not feasible, such as contact conductors, bus bars, and battery connections. Such bare conductors shall be fixed at adequate separations by the use of suitable supports. Except at the point where a permanent ground connection is made, such conductors within buildings shall be kept insulated from the ground. Bare conductors shall not be used where inflammable gases or explosives are liable to be present. (See rules 307 and 314.)

312. IDENTIFICATION OF CONDUCTORS AND TERMINALS.

A. Conductors.

The grounded neutral conductor of multiwire alternating-current circuits, the grounded neutral conductor of three-wire circuits and the grounded conductor of two-wire circuits shall be so arranged as to be readily identified. This may be done by maintaining a specified relative position on open wiring or the conductors may be tagged or otherwise suitably identified if run in conduits. For rubber-covered wires (not including flexible cord or fixture

312. A. Conductors—Continued.

wire) of size No. 6 (0.162 inch) and smaller the only allowable identification shall consist of a white or natural-gray covering. This conductor shall be run and maintained without change in polarity throughout the entire installation and connected at all fittings to marked terminals or to terminals which can be identified by their location relative to others, in order to preserve the continuity of the marking.

If the system to which the circuit is connected is a grounded system, the identified conductor shall be connected to the grounded conductor of this system. The identified conductor shall be connected to the screw shell of all lampholders.

Exception: Identification need not be maintained between switch and equipment controlled.

B. Terminals.

All devices provided with terminals for the attachment of conductors and intended for connection to more than one side of the circuit shall, unless specifically excepted, have a pair of connecting terminals properly marked for identification, unless the electrical connection between the pair of terminals intended to be connected to the grounded conductor is clearly evident.

1. The terminals of lighting panelboards and of devices having a normal rating exceeding 30 amperes need not be marked for identification, except as required in paragraphs 5 and 6 below for polarized receptacles for attachment plugs and polarized attachment-plug caps.
2. The terminals of utilization appliances need not be marked to indicate the proper connection to the grounded conductor. If a terminal of an utilization appliance which includes single-pole switches is marked for identification, the switches shall not be connected in the identified conductor of the circuit.

312. B. Terminals—Continued.

3. The terminals of portable appliances need not be marked for identification.
4. Devices, to the terminals of which only one side of the line is connected, need not have terminals marked for identification.
5. Two-wire attachment-plug receptacles without screw shells, and two-wire attachment-plug caps, unless of the polarity type, need not have their terminals marked for identification. Two-wire polarized receptacles for attachment plugs and polarized attachment-plug caps shall have the terminal intended for connection to the grounded conductor marked for identification.
6. Three-wire attachment-plug receptacles and three-wire attachment-plug caps, in which one terminal may be used for the connection of a grounding conductor, shall have such terminal identified in a manner differing from that specified in rule 312, C. The other terminals need not be marked for identification.
7. In the case of devices with screw shells, the identified terminal shall be the one connected to the screw shell. This does not apply to screw shells which serve as plug fuseholders.
8. In the case of screw-shell devices with attached leads, the conductor attached to the screw shell shall have white or natural-gray finish. The outer finish of the other conductor shall be of a solid color that will not be confused with the white or natural-gray finish which is to indicate the grounded conductor.

C. **Means of Identification of Terminals.**

The marking of terminals shall be done by means of a metallic plated coating substantially white in color, as nickel or zinc, or the terminals may be of material substantially white in color. The other terminals shall be of a readily distinguishable different color.

313. GUARDING AND ISOLATING CONDUCTORS.

Insulated conductors of more than 300 volts to ground, or open, bare, ungrounded conductors of all voltages, if less than 8 feet above the floor or working platform and accessible to unqualified persons, shall be guarded by approved screens, barriers, or inclosures.

314. GUARDING IN DAMP OR HAZARDOUS LOCATIONS.

A. Support of Conductors in Damp Locations.

Conductors in damp locations or where exposed to corrosion, if not in waterproof conduit, or in waterproof metal sheaths in other suitable ducts, shall be effectively isolated and supported on insulators of a suitable type.

B. Conductors in Hazardous Locations.

Conductors in locations where inflammable gas normally exists shall be in grounded rigid metal conduit. All fittings and outlets for conduit shall be electrically and mechanically continuous with the conduit, and the conduit shall be sealed by the use of suitable potheads or equivalent devices to prevent entrance of gases.

Conductors in locations where inflammable flyings normally exist shall be in grounded rigid metal conduit or cable approved for the purpose.

315. PRECAUTIONS AGAINST EXCESSIVE INDUCTANCE AND EDDY CURRENTS.

Supply conductors of alternating-current or direct-current circuits should not be run in separate iron conduits or on opposite sides of **I** beams or other iron structures or be otherwise run so as to increase abnormally the self-inductance of the circuit.

Note: Such construction, by introducing large self-inductance in direct-current circuits, causes fuses to blow explosively; in alternating-current circuits it causes heating due to eddy currents in the metal.

316. Splicing and Taping.

Conductors shall be so spliced or joined as to be mechanically and electrically secure without solder and, unless made with a suitable splicing device, shall then be soldered with a fusible metal or alloy.

Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating covering with other portions of the conductor, and this covering shall be securely held in place.

317. Uninsulated Conductors.

Uninsulated conductors may be used in the following cases under the conditions specified below:

1. As a grounded neutral service conductor, provided the secondaries of the supplying system operate at not more than 208 volts to ground and the conditions specified in rule 93 for a common grounding conductor are met. Except in the service drop, such an uninsulated service conductor shall be part of an approved type of service cable or shall be installed in a rigid metal raceway.
2. As a grounding conductor for equipment, as a common grounding conductor, or as an independent circuit-grounding conductor if used where a common grounding conductor is permissible. (See section 9 for installation method.)

SEC. 32. FUSES, CIRCUIT-BREAKERS, SWITCHES, AND CONTROLLERS

320. General Requirements for Switches.

A. Accessibility, Marking, and Installation.

1. All switches, fuses, automatic circuit-breakers, motor starters, and other control devices shall be readily and safely accessible and shall be installed in such a manner as to minimize the danger of accidental operation.

320. A. Accessibility, Marking, and Installation—Con.

2. The place of operation of starters and controllers for motors, heaters, and furnaces shall be within sight of the motor or equipment controlled, except where it is inaccessible to other than qualified and authorized persons, or where the controller or disconnecting means is capable of being locked in the "off" position.

   Note: This is to minimize the hazard of starting when persons are in dangerous positions, but exception is made to permit the remote control of fans, pumps, etc., when properly isolated.

3. Where practicable, switches shall be so installed that gravity can not close them; and such switches as may close by gravity shall be provided with a stop block or latch to prevent accidental closing.

4. Oil switches and oil circuit-breakers shall be marked with the following data:
   (a) Manufacturer's name and address.
   (b) Manufacturer's type and designation number.
   (c) Rated amperes.
   (d) Rated volts.
   (e) Frequency if other than 60 cycles.

   Such marking shall be placed on the switch or circuit-breaker and not on removable parts that may be interchanged.

B. Switches for Special Circuits.

Switches controlling emergency lighting circuits, elevator circuits, circuits in theaters, hospital operating rooms, and other circuits, the interruption of which might cause special hazard, shall be arranged so as to be accessible only to authorized persons.

C. Control of Exit and Emergency Lights.

In buildings where emergency and exit lamps are installed, the control switch shall be located where it will be under competent supervision.

D. Control of Exit Lights in Assembly Halls.

Exit lamps and all lamps normally kept lighted in halls, corridors, and any other parts of theaters and

320. D. Control of Exit Lights in Assembly Halls—Con.

other public assembly halls used by the audience except the general auditorium lighting, shall be supplied independently of the stage lighting, and shall be controlled from the lobby or other place convenient to the main entrance to the building. In addition to the control required by the foregoing, there may be—

1. A switch at the main service or on the control panel of special current source.
2. A switch located adjacent to the emergency switch, or an automatic light-actuated device approved for the purpose, to control separately those lights on the exterior of the building which are not required for illumination when there is sufficient daylight.

321. HAZARDOUS LOCATIONS.

When necessary to install fuses, circuit-breakers, switches, or other control devices in locations where explosives, inflammable gas, or inflammable flyings exist, they shall be suitably protected. (See rule 307.) Flush snap switches, if mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces, shall be provided with covers of nonconducting material. (Usually grounded surfaces within 5 feet horizontally of the parts considered and within 8 feet vertically of the floor are considered within reach).

322. WHERE SWITCHES ARE REQUIRED.

A. Service Switches.

Suitable switches and fuses, or circuit-breakers, or equivalent devices shall be installed in all ungrounded service conductors connecting utilization installations to the main service conductors from either overhead or underground lines. If fuses are used, unless access to them is under the control of the electric service company, they shall be disconnected by opening the service switch.

322. A. Service Switches—Continued.

Service switches and fuses, or circuit-breakers, or equivalent devices shall be readily accessible and as close as practicable to the point where the service enters the building.

Unless mounted upon a switchboard or panelboard accessible to qualified persons only, service switches, fuses, and circuit-breakers shall be inclosed. Switches shall be operable without opening the inclosure unless additional switches are provided for separate control of the individual circuits, such switches being inclosed and externally operable.

If supply is from two or more different sources, the switch or switches controlling the supply shall be so constructed or arranged that it will be impossible to connect to one source unless the other is disconnected.

Exception: Floating batteries or supply units or systems normally operated in parallel.

B. Circuit Switches.

Suitable switches, circuit-breakers, or equivalent devices shall be inserted in all circuit leads to lamps, motors, transformers, storage batteries, electric furnaces, and similar utilization equipment to make possible the disconnection of all such equipment from the source of supply.

Note: On a branch circuit not exceeding 15 amperes or 150 volts, plug fuses are recognized as an equivalent device.

Exception 1: Parts or pieces of apparatus intended to operate as a unit, as a motor and its starting device, may be controlled by one switch.

Exception 2: The switch need not open a grounded conductor. (See rule 310, B and C.)

Exception 3: A group of incandescent lamps on the same branch circuit may be disconnected by one single-pole switch in the ungrounded conductor.

Exception 4: One switch may serve to disconnect several motors and their starting devices from the source of supply, if it complies with rule 308.

322. B. Circuit Switches—Continued.

Note: The use of a disconnecting means for each motor or a group of motors is a question of judgment, depending upon the frequency of attention required by the motor and controller.

Single-pole switches shall not be placed in any neutral or grounded conductor. Three-way switches, or three-way and four-way switches used in combination, shall be classed as single-pole switches, and shall be so wired that only one pole of the circuit will be carried to any switch.

C. Fuses.

Switches shall be provided as necessary to make possible the disconnection of all fuses from the source of electrical supply before being handled, except as provided in 324, B.

D. Switches or Plugs on Portables.

Switches or plug connectors shall be installed to permit the disconnection of temporary wiring, or of portable conductors from permanent or fixed wiring.

E. Emergency Stop Switches.

On equipment where the failure of any part of the operating or control circuits may create a life hazard and on equipment where there is possibility of the operator being caught or injured in the normal operation of the machine (such as rolls, mixers, beaters, etc.), an emergency stop switch shall be provided accessible to the operator in his usual working location. This switch shall be of a different color from any other switches on the operating or control panel and shall be clearly marked "Emergency Stop." Such switch shall not be dependent upon the action of springs for opening but shall be positively opened by the movement of the operating member itself. Springs may, however, be used to accelerate the separation of current-carrying parts. The circuit shall be so arranged that once the emergency stop switch has been operated, the equipment

322. E. Emergency Stop Switches—Continued.

cannot be started without going through the normal starting sequence.

323. CHARACTER OF SWITCHES AND DISCONNECTORS.

A. Interrupting Capacity of Switches.

Switches used otherwise than as disconnectors shall have a capacity such as to insure safe interruption, at the working voltage, of the greatest current which they will be required to carry continuously, and shall be marked with the current and voltage for which they are rated.

B. Capacity of Disconnectors and Warning Signs.

Disconnectors shall be of suitable voltage and ampere rating for the circuit in which they are installed and shall be accessible only to properly qualified persons. They shall also be protected by signs warning against opening them while carrying current in excess of the safe opening limit.

Note: Interlocking arrangements are desirable to prevent opening of such disconnectors under loads beyond their safe opening capacity and locking arrangements to prevent accidental opening.

C. Locking or Blocking.

Where dependence for maintaining an open circuit as a protection for persons against unexpected starting or energizing the circuit is put on certain switches or circuit-breakers, such switches or circuit-breakers shall be so arranged that they can be locked, blocked, or otherwise secured in the "Off" or "Open" position. (See rules 328, A and B, and 329 L.)

Exception: Small-capacity snap switches, if near machines and in plain sight from all parts of the machines controlled, are exempted. Switches of any size are exempted if the installation comprises only one motor, and the switch is in plain sight from all parts of the machines operated by the motor.

323. C. Locking or Blocking—Continued.

Note: Locking is to be preferred to blocking, wherever parts of the machinery driven are remote from the point of control.

D. Good Contact.

Switches, controllers, and rheostats shall be so constructed as to make and maintain good contact. Knife switches shall maintain such alignment under service conditions that they may be closed with a single unhesitating motion.

E. Inclosure of Switches.

Switches shall be of inclosed type unless inaccessible to other than qualified persons (see rule 328).

F. Manual Operation for Power-Operated Apparatus.

Power-operated circuit-breakers and similar switching apparatus, excepting magnetic contactors, shall be provided with means for readily closing and opening them manually.

324. DISCONNECTION OF FUSES AND THERMAL CUT-OUTS BEFORE HANDLING.

A. Automatic Disconnection.

Fuses in circuits of more than 150 volts to ground shall, where accessible to others than qualified electrical attendants, be so arranged that the fuses are necessarily disconnected from all sources of electric energy before they can be touched. Where the circuit voltage is less than 150 volts to ground, this protection is recommended.

Note: This may be accomplished by a construction in which the fuse and its exposed current-carrying connections are accessible only when disconnected from the circuit, either by opening the fuse inclosure or by other means.

Where fuses are in locked cabinets (or otherwise made accessible only to qualified persons) sufficient protection is usually secured for all voltages if switches are provided to disconnect the fuses from all sources of electric energy.

If switches and fuses are in closed in metal cabinets and live terminals are accessible, greater hazard to one

324. A. Automatic Disconnection—Continued.

replacing a fuse exists than if they were not so inclosed, as the live terminals are adjacent to grounded metal.

B. Switch Ahead of the Fuse.

Where fuses are not arranged so that they are necessarily disconnected from all sources of electric energy before they can be touched, switches shall be so placed or arranged that opening them will disconnect the fuses from all sources of electric energy, except service and meter switches, access to which is controlled by the electric service company. If in order to comply with the above, the supply wires must be connected to certain terminals, such terminals shall be marked "Line" and the other terminals shall be marked "Load," or with other appropriate designation.

Electric meters and control circuits of time switches may be connected on the supply side of the service switch and fuses or circuit breaker on alternating-current supply not exceeding 300 volts between conductors, provided no wiring or live parts are exposed and the connections are inaccessible to unauthorized persons.

C. Live Load.

Where a fused inclosed switch, accessible to unqualified persons, is connected between a source of supply and a live load of more than 150 volts to ground, as in the charging circuit of a storage battery, switches shall be used in which the fuses are so arranged that they will be disconnected before they become accessible unless a supplementary switch is provided for disconnection of the live load from the fuses.

D. Thermal Cut-Outs.

Thermal cut-outs shall comply with the requirements for fuses in *A* and *B*.

325. ARCING OR SUDDENLY MOVING PARTS.

A. Location.

Fuses and circuit-breakers shall be so located and shielded that persons will not be burned or otherwise injured by their operation.

B. Suddenly Moving Parts.

Handles or levers of circuit-breakers and similar parts which may move suddenly in such a way that persons in the vicinity are liable to be injured by being struck by them shall be guarded or isolated.

326. GROUNDING NONCURRENT-CARRYING METAL PARTS.

Exposed noncurrent-carrying metal parts of switch and fuse cases, levers, and other similar parts to which leakage may occur from live parts shall be effectively grounded according to the provisions of rule 304.

Exception: Small parts, such as name plates, screws, and metal covers of fuses and switch bases, which are thoroughly and effectively insulated, and which are not liable to become alive except under very unusual circumstances, are not considered as coming under the rule and may be left ungrounded.

327. GUARDING LIVE PARTS.

A. Guard Disks and Handles.

All manual switches, except switches less than 150 volts to ground and limited by fuses or automatic circuit-breakers to 60 amperes, shall have suitable casings or guards protecting the operator from danger of contact with current-carrying parts, or shall be provided with insulating handles and suitable insulating guard disks or shields so arranged between the handles and the live parts as to prevent the hand from slipping into contact with live parts or being burned by arcing at the switches.

327. Guarding Live Parts—Continued.

B. Inclosure.

Current-carrying parts of switches, fuses, or automatic circuit-breakers of more than 300 volts to ground shall be provided with inclosing guards, effective during ordinary operation; and if accessible to other than qualified persons, current-carrying parts of more than 150 volts to ground shall be provided with such inclosing guards.

C. Platforms and Mats.

Where switches or fuses of more than 150 volts to ground are not guarded during ordinary operation, suitable insulating floors, mats, or platforms shall be provided on which the operator must stand while handling the switches, fuses, or automatic circuit-breakers, and (unless operators invariably wear suitable insulating gloves while handling the switches) any conducting walls or machine frames within 3.5 feet shall be provided with suitable insulating guards.

Note: The suitable guarding of live parts will obviate the necessity for such insulating floors and other devices, and where use of such devices is impracticable from the nature of the location or mechanical process carried on, guards should always be used.

D. Blades Dead.

Single-throw switches shall be so connected as to have no exposed blades alive when a switch is open.

328. INCLOSED AIR-BREAK SWITCHES (NOT INCLUDING SNAP SWITCHES).

A. Locks for Switches.

Inclosed switches, if used to comply with the requirement in rules 308 (5); 323, C; 329, H2; and 363, D, shall be provided with means for locking or sealing the switch in the "Off" position.

B. Locks for Disconnectors.

Inclosed disconnectors shall have provisions for locking in both open and closed positions, where accessible to unqualified persons.

328. Inclosed Air-Break Switches—Continued.

C. Marking.

Inclosed switches shall be plainly marked to show the manufacturer's name or trade-mark, the rating of the switch in amperes and volts (ac or dc), the open and closed positions of the switch handle, and when necessary for proper functioning, the terminals to be connected to "Line" and "Load." The marking of the manufacturer's name, the voltage, and the open and closed positions shall be on the outside of the case.

D. Operating Handle.

Switches of the inclosed type shall be externally operable, and the external operating handle (if one is used) shall be of substantial construction, readily accessible, and provided with positive stops limiting its motion.

E. Grounding.

Inclosures and metal handles of switches shall be effectively grounded according to the provisions of rule 304, C.

Note: Where a handle consists of a metal rod using the wall of the case as a bearing, and a test at rated voltage shows that the two make electrical contact, the handle will not need a separate ground connection.

F. Unused Openings Plugged.

All unused conduit and wiring openings in switch inclosures shall be effectively closed by metal plugs or plates.

329. CONTROL EQUIPMENT.

A. Classes of Inclosures.

Inclosures are classified as follows:

Class I.—A solid inclosure without slot or other opening.

Class II.—A solid inclosure except for a slot for the operating handle or openings for ventilation, or both.

Class III.—Wire mesh, perforated screens, or grillwork.

329. Control Equipment—Continued.

B. Material for Inclosures.

Cast metal for inclosures whether of iron or other metal, shall be at least ⅛-inch in thickness at every point and of greater thickness at reinforcing ribs and door edges; except that die-cast metal may be not less than 3/32 inch in thickness for an area greater than 24 square inches or having any dimension greater than 6 inches, and may be not less than 1/16 inch in thickness for an area of 24 square inches or less, or having no dimension greater than 6 inches. Cast metal shall be at least ¼-inch in thickness at threaded holes for conduit.

The minimum thickness required for sheet-metal construction varies with the size of the device. For classes I and II, protective parts of sheet metal shall be of gage not less than that given in table 1.

TABLE 1.—*Thickness of inclosures*

Maximum volume of inclosure	Maximum area of any surface	Maximum dimension	Minimum thickness of metal—U. S. Std. Gage	
			Without supporting frame	With supporting frame or equivalent reinforcing
cu ft	*sq in*	*in.*		
¾	------------	12	20	24
1	------------	18	18	20
--------	360	24	16	18
--------	1, 200	48	14	16
--------	1, 500	60	12	16
--------	Over 1, 500	--------	10	16

Wire screening used for inclosures shall conform to the following:

Maximum opening in screen	*Minimum wire size, Steel wire gage*
½ inch	No. 16
More than ½ inch and not more than 2 inches	No. 12

If the opening is more than one-half inch, the inclosure shall not be less than 4 inches from any live part.

329. Control Equipment—Continued.

C. Clearances.

1. There shall be sufficient space within the inclosure to permit uninsulated parts of wire terminals to be separated so as to prevent their coming in contact with each other. Inclosures shall be such as to permit proper wire connections to be made with adequate spacing of the terminals and ends of conductors from adjacent points of the inclosures.
2. Exposed nonarcing current-carrying parts within the inclosures shall have an air space between them and the uninsulated part of the inclosure of at least ½ inch for 750 volts or less, except that in a controller or other small device rated at not more than one horsepower and 300 volts and having an inclosure adequately rigid, the spacing may be less than ½ inch but not less than ⅛ inch in air nor less than ¼ inch over the surface of insulating material. Inclosures of sizes, materials, or forms not having adequate rigidity shall have greater spacing. A suitable lining of insulating material not less than $\frac{1}{32}$ inch in thickness may be provided in lieu of the air space of ½ inch.

D. Securing Covers, Etc.

All inclosures and parts of inclosures, such as doors, covers, tanks, etc., shall be provided with means for firmly securing them in place. Among the available means are locks, interlocks, screws, and seals.

E. Rating of Controller.

A controller shall have appropriate ratings of voltage, frequency, and horsepower.

F. Marking of Controllers.

1. Controllers should be marked to indicate the duty for which they are designed, such as starting, intermittent, varying, continuous, etc.
2. Controllers shall be marked with their ratings in volts and horsepower and in addition if for alternating current, the cycles and number of phases.

329. F. Marking of Controllers—Continued.

3. Parts of controllers which are operated manually (controller handles, push-button stations) shall be marked, if necessary, to indicate proper operation.
4. Every controller shall be provided with a wiring diagram and, where practicable, this diagram shall be permanently attached to the controller or its mounting. All incoming and outgoing terminals of the control equipment shall be marked to correspond with the markings on the diagram.

   Note: It is very desirable that instruction books, tags, or cards accompany each controller installation, showing in detail how to properly repair and adjust various parts of the equipment.

5. Field rheostats shall be marked to indicate the total ohms, volts, ampere capacity of first step, and ampere capacity of last step.
6. A thermal cutout used as part of the control equipment shall be marked with the maximum rating of the fuse with which it can be used safely.

G. Guarding Live Parts.

1. Controllers and electric remote-control stations operating at 50 volts or more between conductors shall be guarded against accidental contact of persons with live parts by inclosure or guarding or location.
2. Manual controllers and manually operated electric remote-control stations operating at more than 150 volts to ground shall be externally operable.
3. Controllers shall be guarded against contact with live parts by conducting objects by inclosure or guarding or location. Consideration shall be given to possible hazards, from above, from cranes or other moving apparatus; from below by objects placed under the controller mounting; and from objects being carried by persons, such as pipe, tools, etc.

329. Control Equipment—Continued.

H. Protection for Workmen.

1. Any controller installation operating at over 300 volts to ground which, for any reason, must be alive when maintenance work is being done shall comply with the following:
   (a) Live parts shall be accessible only to qualified and authorized persons.
   (b) An insulating mat or platform shall be provided on which a person must stand while inspecting or working on the controller.
   (c) Any conducting surfaces within 3½ feet of the controller shall be provided with insulating guards.
   (d) Non-current-carrying metal parts of the controller, such as the mounting frame and metal shields, shall not be grounded and shall be installed effectively insulated from ground.

   Note: See also part 4 for safe practices in working on live equipment.

2. Means shall be provided for disconnecting all ungrounded conductors from the controller, except that controllers described in subparagraph 1 above are not required to have such disconnecting means if the controller opens all ungrounded conductors to the motor. The disconnecting means may be in the same inclosure or on the same panel as the controller. If not within sight of the controller, it shall be provided with means for locking it in the open position.

I. Guarding Arcing Parts.

Controllers shall be so located or shielded as to protect operators and other persons in the vicinity from burns or eye-flash which might result from arc-rupturing parts and so as to prevent arcing to adjacent surfaces. For this latter purpose, controllers installed without inclosure, and controllers

329 I. Guarding Arcing Parts—Continued.

whose inclosure is built up during or after installation of the controller, shall have the air spaces (or barriers) given in table 2 between arc-rupturing parts and the walls of metal inclosure or other adjacent surface.

TABLE 2.—*Air spaces in controllers*

Horsepower rating	Distance from contacts in direction of blow-out		Vertical distance above contacts without blow-out				Horizontal distance from contacts and distance below contacts	
	dc and ac		dc		ac		dc and ac	
	300 volts	750 volts	300 volts	750 volts	300 volts	750 volts	300 volts	750 volts
	Inches	*Inches*	*Inches*		*Inches*	*Inches*	*Inches*	*Inches*
5	1¾	3	4	(1)	1¾	3	¾	1½
10	2	4	5	(1)	2	4	¾	1½
50	3	5	6	(1)	3	5	1	2
100	4	(1)	(1)	(1)	4	(1)	2	3
Above 100	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)

[1] Barrier.

NOTES.—All distances to be measured from contact tips or arc horns.
Voltage values given are between conductors.

J. Location of Controller.

All points from which the motor is controlled shall be within sight of the motor unless that is impracticable, in which case there shall be means readily available to the person inspecting the motor for preventing operation of the controller.

K. Overcurrent Protection.

Control equipment shall include an automatic device which will interrupt the electric power if the current exceeds a predetermined value. Such overload protection need not be a part of the controller but may be a separate unit. If a part of the controller, such overload protection shall conform to all applicable rules for the control equipment.

329. Control Equipment—Continued.

L. Under-Voltage Protection.

If the automatic restarting of a motor on restoration of voltage may result in injury to any person, under-voltage protection shall be furnished. See 340, D.

M. Open-Phase or Phase-Reversal Protection.

If the motor operates equipment which is of such a nature that the opening of one phase of a polyphase circuit or the reversal of a phase or phases would result in possible injury to any person, means shall be provided which will prevent starting of the motor under such a condition.

SEC. 33. SWITCHBOARDS AND PANELBOARDS

330. Accessibility and Convenient Attendance.

A. Control Arrangement.

Switchboards and panelboards shall have all switches so arranged that the means of control are readily accessible to the operator.

B. Location of Instruments.

Instruments, relays, or other devices requiring reading or adjusting shall be so placed that work can be readily performed from the working space provided.

331. Location and Illumination.

Switchboards shall be so placed that the persons necessarily near the board will not be endangered by machinery or equipment located near the board. Means for adequate illumination shall be provided.

Switchboards shall be made of noncombustible material and shall be kept free from moisture.

Switchboards shall be so installed and supported that they will withstand the stresses imposed by the operation of the apparatus mounted thereon, braces or other framework being installed if necessary.

332. Arrangement and Identification.

Connections, wiring, and equipment of switchboards and panelboards shall be arranged in an orderly manner

332. Arrangement and Identification—Continued.
and all switches, fuses, and automatic circuit-breakers shall be plainly marked, labeled, or arranged so as to afford ready means for identifying circuits or equipment supplied through them.

It is recommended that a diagram of switchboard or panelboard connections and devices be kept posted in some convenient place near such equipment.

333. SPACINGS, BARRIERS, AND COVERS.

A. Separation of Bare Parts.

Bare parts of different potential on the front of switchboards, if accessible to unqualified persons, shall be so located or protected that they will not be readily short-circuited by tools or other objects.

B. Portable Covers or Shields.

Switchboards shall have current-carrying parts which are ordinarily isolated or guarded, but which may occasionally require adjustment or repair while alive, so arranged that suitable portable covers or shields can be effectively placed to protect workmen from contact with any neighboring live parts.

334. GROUNDING FRAMES.

Switchboard frames and metal cabinets shall be effectively grounded, with the exceptions noted in rule 304.

335. GUARDING CURRENT-CARRYING PARTS.

A. Inclosure of Parts at More Than 150 Volts to Ground.

No switchboard or panelboard operating at more than 150 volts to ground shall have current-carrying parts exposed within 8 feet of the floor, unless accessible only to qualified operators. Parts of 100 to 150 volts to ground should not be accessible to unqualified persons. Locked cabinets or other inclosures may be provided where necessary to prevent such exposure. If the current-carrying parts are at any time exposed while alive, conducting floors about such boards shall be provided with a suitable

335. A. Inclosure of Parts at More Than 150 Volts to Ground—Continued.

insulating platform or mat so placed that no live parts can be inadvertently touched except while standing on the platform or mat. (See rules 306 and 327.)

B. Inclosure of Low-Voltage Parts.

All switchboards and panelboards should be so arranged that current-carrying parts less than 150 volts to ground and less than 5 feet above the floor are inclosed in cabinets or screens.

Note: This is an effective precaution against accidental short-circuit or contact by persons in the vicinity.

C. Plug-Type Boards.

Plug-type switchboards if of more than 150 volts to ground, shall have no current-carrying parts exposed on face of boards, and plug connectors shall have all current-carrying parts guarded as long as they are alive.

D. Dead-Front Boards.

Switchboards having no current-carrying parts exposed on the face (working space) shall be used in theaters and similar places where rapid handling is necessary and the attention must be given to signals or to other processes.

E. Theater Boards.

Theater switchboards at any voltage having current-carrying parts exposed on back to passersby shall be elevated or guarded by suitable railings to prevent contact with live parts.

336. FUSES ON SWITCHBOARDS.

A. Disconnection of Fuses.

Fuses on switchboards shall be arranged in one of the following ways:

1. So that they are necessarily disconnected from all sources of electric energy before they can be touched.

336. A. Disconnection of Fuses—Continued.

2. So that they can be disconnected from all sources of electric energy by a switch.
3. So that they can be conveniently handled by means of suitable insulating tools provided for the purpose.

When switchboards are accessible to unqualified persons the protection specified in 1 shall be provided if the voltage exceeds 150 volts to ground and should be provided if the voltage is less than 150 volts to ground.

B. Location of Fuses.

Fuses shall be so located as to obviate the danger in removing or replacing them of short-circuiting other live parts. Open-link fuses shall not be installed on switchboards.

337. PANELBOARDS.

A. Arrangement of Equipment.

1. LOCATION OF FUSES.

Fuses shall be so located as to limit as far as practicable the danger of short-circuiting other live parts when removing or replacing them.

2. CONNECTION OF PLUG-FUSE SHELLS.

The shells of plug-fuse holders in ungrounded conductors shall be connected to the load side of the circuit on all panelboards employing plug fuses without switches in main or branch circuits.

B. Material.

Panelboard bases shall be made of nonabsorptive, noncombustible insulating material.

C. Marking.

Panelboards shall be plainly marked to show the manufacturer's name or trade-mark and the rating in volts and amperes. The ampere rating shall be the maximum capacity of the busses.

337. Panelboards—Continued.

D. Protection Against Moisture.

Where panelboards are installed so as to be exposed to excessive moisture they shall be inclosed in weatherproof cabinets.

E. Hazardous Locations.

Panelboards shall not be installed where hazardous conditions exist due to the presence of inflammable gas or inflammable dust or flyings, except as permitted by rule 307.

F. Residences.

Panelboards in residences shall be so installed that the lowest live part exposed when the cabinet door is open to permit operation of switches shall not be less than 4 feet from the floor.

SEC. 34. MOTORS AND MOTOR-DRIVEN MACHINERY

340. CONTROL DEVICES.

A. Speed Limitation.

Machines of the following types shall be provided with speed-limiting devices, unless their inherent characteristics or the load and the mechanical connection thereto are such as to safely limit the speed or unless the machine is always under the manual control of a qualified operator:

1. Separately excited direct-current motors.
2. Series motors.
3. Motor-generators and converters which can be driven at excessive speed from the direct-current end as by a reversal of current or decrease in load.

Note: The required limitation of speed may be obtained by the use of a relay, centrifugal switch, or other similar device which will cut off the supply of energy when excessive speed is attained.

B. Adjustable-Speed Motors.

Adjustable-speed motors, if controlled by means of field regulation, shall be so equipped and connected

340. B. Adjustable-Speed Motors—Continued.

that the field cannot be weakened sufficiently to permit a dangerous speed, and so that the motor cannot be started under weakened field unless the motor is designed for such starting.

C. Wiring.

Where speed-limiting devices or remote-control switches are electrically operated, the control circuits by which such devices are actuated shall be adequately guarded, by conduit or otherwise, against mechanical injury.

D. Under- or Low-Voltage Protection.

Where the restarting of the motor on restoration of voltage may result in injury to any person or persons, under- or low-voltage protection shall be furnished. When the motor and driven machinery are isolated and accessible to qualified persons only, the provision of a disconnecting switch eliminates the hazard.

341. HAZARDOUS LOCATIONS.

Motors in which sparking or arcing can occur during operation shall, when in locations where explosives or inflammable gas or inflammable flying exist, be suitably protected as described in rules 307 and 304, C.

342. DETERIORATING AGENCIES.

A. Inclosures.

Suitable guards or inclosures shall be provided to protect exposed current-carrying parts of motors and the insulation of motor leads where installed directly under equipment or in other locations where dripping oil, excessive moisture, steam, vapors, chemicals, or similar injurious agencies exist.

B. Grounding Frames.

The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be effectively grounded. (See rule 304, C.)

343. GUARDS FOR LIVE PARTS.

A. Inclosure of Live Parts.

Motors of more than 150 volts to ground, unless isolated by elevation at least 8 feet above the floor line, should be provided with permanent inclosures or other suitable guards so arranged as to prevent persons or conducting objects from inadvertently coming or being brought into contact with live parts or interfering with the operation of the motors.

B. Mats and Platforms.

Suitable insulating mats or platforms of substantial construction and providing good footing shall be so placed on floors and, if necessary, on frames of machines having exposed live parts of more than 150 volts to ground that the operator or other persons in the vicinity cannot readily touch such parts unless standing on the mats, platforms, or insulating floors.

Note: The suitable guarding of live parts by inclosures or barriers effective during attendance or necessary adjustments of live parts will obviate the necessity for insulating mats, and where such mats are impracticable from the nature of the location or processes carried on, guards shall always be used.

Where connectors are used in motor leads, these should be provided with insulating covering equal to that on the conductors.

C. Steps and Handrails.

Where necessary, steps and handrails should be installed on or about large machines to afford safe access to live parts which must be examined or adjusted during operation.

344. GROUNDING MACHINE FRAMES.

Where two or more machines, either of which operates at more than 150 volts to ground, are mechanically coupled together, and the operator can touch the frames of more than one at a time, the frames of all such machines shall be effectively grounded as required by rule 304, *C*, unless they are bonded together electrically and

344. Grounding Machine Frames—Continued.

surrounded by insulating mats or platforms on which persons must stand in order to touch the machine frames. If operating at more than 300 volts to ground, their frames shall always be grounded as required by rule 304, *C*, and frames shall also be grounded wherever, from the nature of the location or of processes carried on, the use or maintenance of insulating mats or platforms is impracticable.

345. Protecting Moving Parts.

Suitable guards or inclosures shall be arranged at each motor or motor-driven machine when necessary to prevent persons or objects from inadvertently coming in harmful contact with moving parts, including chains, belts, gears, and pulleys.

SEC. 35. ELECTRIC FURNACES, STORAGE BATTERIES, TRANSFORMERS, AND LIGHTNING ARRESTERS

350. Protection from Burns.

A. Inclosure of Glowing Parts.

Electric furnaces and apparatus used for arc welding, where intensely glowing incandescent or arcing parts are exposed, shall be inclosed so that those parts will not be accessible or visible to unqualified persons.

B. Screens, Hoods, Goggles.

Suitable protecting screens, hoods, goggles, gloves, and other devices shall be provided for the qualified persons who must work or come near such exposed parts. (See American Standard Safety Code for the Protection of the Heads, Eyes, and Respiratory Organs, ASA Z2, for mechanical and optical protection.)

351. Grounding of Furnace Frames.

The outside noncurrent-carrying metallic frames of furnaces shall be effectively grounded if they contain cur-

351. Grounding of Furnace Frames—Continued.

rent-carrying parts connected to circuits of more than 150 volts to ground, or if the circuit within is not grounded and is exposed through transformer windings to a circuit of more than 150 volts to ground.

352. GUARDING LIVE PARTS.

Except at points where necessarily left exposed (as at spot-welder contacts), current-carrying parts of furnaces, welders, and control equipment of more than 150 volts to ground, shall be suitably guarded with inclosures or barrier guards.

353. STORAGE BATTERIES.

The installation of nonportable storage batteries shall be in accordance with section 13 of the rules for stations (part 1).

354. TRANSFORMERS.

The installation of transformers having either winding of more than 300 volts to ground shall comply with the rules of section 14 of the rules for stations, and if the operating voltage of any winding exceeds 750, the transformers shall be made inaccessible to unqualified persons.

355. LIGHTNING ARRESTERS.

The installation of lightning arresters shall comply with the rules of section 18 of the rules for stations, and if the operating voltage of the circuit exceeds 750 volts between conductors, the arresters shall be inaccessible to unqualified persons.

Lightning arresters when installed for the protection of utilization equipment may be installed on supply lines or service leads either within or without the buildings or inclosures containing the equipment to be protected. They shall be installed in accordance with the rules of parts 1, 2, or 3 depending upon their location, whether in stations, on outdoor lines, or with utilization equipment.

SEC. 36. LIGHTING FIXTURES AND SIGNS

360. FIXTURES.

A. Grounding.

The exposed noncurrent-carrying metal parts of all lighting fixtures, receptacle plates, and switch plates and other similar fixed electric devices shall be effectively grounded when used under the following circumstances (for exception, see rule 304, C.):

1. If in locations where explosives, inflammable gas, or inflammable flyings exist in dangerous quantities.
2. If within reach of bathtubs, shower baths, plumbing fixtures, steam piping, or other grounded metal surfaces of the building. Metal pull chains used at these locations shall be provided with insulating links. (Usually grounded surfaces within 5 feet horizontally of the parts considered and within 8 feet vertically of the floor are considered within reach).
3. If connected to circuits operating in excess of 150 volts to ground, regardless of location.

   Exception: Grounding is not required if the fixture, shell of socket, lamp guards, etc., are made of or covered with suitable insulating material.

B. Gas Piping as Electrode.

Gas piping may serve as the grounding electrode for fixtures located at a considerable distance from water piping. (See section 9 for method).

C. Polarizing Lampholders.

On grounded systems the center contacts of lampholders shall be connected to the ungrounded side of the system, and the inner screw shells of the devices to the grounded side or neutral.

Note: This is in order to reduce the liability of break-down of the dielectric between the inner screw shell and the grounded outer brass shell, and also to reduce the liability of injury to persons in replacing lamps. This is especially important in wiring electric signs.

361. RECEPTACLE FOR CONVENIENCE OUTLET.

Receptacles installed for the attachment of portable cords shall be of a type not suitable for use with screw-shell-base devices.

362. EXPOSED LIVE PARTS.

Electric fixtures, including lamp sockets and lamp bases, if within reach of grounded surfaces, shall be so designed and installed that no current-carrying parts will normally be exposed externally.

363. SIGNS.

A. Accessibility.

Electric signs at an elevation greater than 30 feet above roadways or footways, or at an elevation above a roof greater than the distance from the edge of the roof, shall, if they require attendance while in position, be provided with substantial, safely accessible, runways, ladders, or platforms from which all replacements and other necessary adjustments can be made. Provision for supporting workmen by safety belts should be made in the construction and installation of signs so located.

B. Inclosure of Live Parts.

Electric signs outside buildings shall have no ungrounded current-carrying parts normally exposed to contact.

C. Grounding of Noncurrent-Carrying Parts.

The exposed noncurrent-carrying metal parts of signs shall be effectively grounded, unless they are insulated from ground and from other conducting surfaces and are inaccessible to unauthorized persons. This does not apply to signs of the portable incandescent lamp type.

D. Control.

Electric signs, other than the portable type, shall be provided with switches arranged to entirely disconnect all ungrounded supply wires of the sign, and either located within sight of the sign or arranged so that they can be locked in the open position.

364. CONNECTORS FOR SIGNS.

Electric signs with changeable connections shall be so arranged that the connections can be changed manually only by approved connectors. Approved connectors shall interrupt all ungrounded conductors of the circuit.

365. LAMPS IN SERIES CIRCUITS.

A. In or on Buildings.

Series lamps mounted in buildings or on external walls of buildings shall be installed only by permission of the administrative authority.

B. Elevation.

Arc and incandescent lamps and other devices in series circuits, except in grounded circuits of which no part exceeds 150 volts to ground, shall be effectively isolated or suitably guarded.

Note: Isolation will ordinarily be deemed sufficient when a vertical clearance of 8 feet is provided from floors or other ordinarily accessible places within buildings, of 10 feet from footways outside buildings, and of 15 feet from roadways. Horizontal clearance from windows, porches, and other spaces accessible to the general public should be not less than 3 feet.

C. Suspension of Lamps.

Lamps shall be securely supported, and the hanger, rope, chain, or other means of support shall be regularly and systematically inspected. All metal cable or chain supports for lamps shall be effectively insulated from the lamp or shall be permanently grounded. Metal chains or metal cables and other conducting parts used for lowering lamps in series circuits shall be grounded or interrupted by a suitable strain insulator, the minimum height of which from the floor or ground shall be 8 feet, whether the lamp is in position or lowered.

366. SAFE ACCESS TO ARC LAMPS.

A suitable device shall be provided by which each arc lamp or other device on series circuits may be safely and entirely disconnected from the circuit before it is han-

366. Safe Access to Arc Lamps—Continued.

dled, unless the lamps are accessible only to properly qualified persons, worked on only from suitable insulating stools, platforms, or tower wagons, and treated always as under the full voltage of the circuit concerned

SEC. 37. PORTABLE APPLIANCES, CABLES AND CONNECTORS, AND INSECT ELIMINATORS

[Not including those for communication systems]

370. INSULATION.

Portable appliances and devices shall be provided with an adequate dielectric (complying with the standardization rules of the American Institute of Electrical Engineers) interposed between ungrounded current-carrying parts and those external surfaces which persons can touch.

Exception: Toasters, grills, or other heating appliances in which the current-carrying parts at high temperature are necessarily exposed are exempted. (Compare rule 352.)

In locations where the dielectric is exposed to mechanical injury it shall be suitably protected.

371. GROUNDING OF FRAMES.

A. Grounding Noncurrent-Carrying Metal Parts.

Portable appliances and devices operating on circuits of more than 150 volts to ground, shall have their exposed metal frames grounded except (1) motors, if guarded; and (2) electrically heated appliances exempted by the administrative authority. The exposed metal frames of portable appliances and devices used in hazardous locations as listed in rule 307, A, shall be effectively grounded, regardless of the voltage of the circuit.

The effective grounding of exposed metal frames of portable appliances and devices (especially when used in locations such as bathrooms, laundries, etc., under conditions where persons may easily touch

371. A. Grounding Noncurrent-Carrying Metal Parts—Con.

grounded surfaces at the same time as the appliance or device) is recommended.

Note: Such grounding may be obtained by the use of a three-wire portable cord with the portable appliance or device, one wire being used for the grounding conductor and the connectors being properly designed so that wrong connections cannot be made by the user of the device. Safety may be accomplished and the need for grounding eliminated in many cases by insulating the metal frame from contact by persons, or by isolation of the device.

It is recommended that in industrial establishments portable lamps which are to be used in conductive locations, be operated at 32 volts or less between conductors through the use of step-down transformers, thus obviating the need for grounding such portable equipment.

B. Sockets and Fixtures of Insulating Material.

Sockets, fixtures, lamp guards or similar devices constructed or covered with suitable insulating material may be used in lieu of grounded metal devices, and should be used in locations such as bathrooms, laundries, etc.

372. CABLE CONNECTORS.

A. Break All Conductors.

Where used with portable conductors, it is recommended that connectors be used which necessarily disconnect both or all poles from the live source of energy when the circuit is opened.

B. Design of Connectors.

Connectors shall be so constructed (with guards when necessary) that the person using them cannot inadvertently come in contact with live parts, or be burned by arcing when interrupting the largest current for which they are rated or marked.

Separable connectors should be so designed that the plugs will not fit receptacles rated for larger currents than the plugs.

372. Cable Connectors—Continued.

C. Live Parts of Connectors.

The end of a separable connector which is left alive, or the two ends of a separable connector where both are connected to live circuits (as in battery charging), shall have live parts suitably guarded.

D. Strain Relief.

Where connectors are attached to portable cables, suitable means shall be provided for relieving the terminal connections of cable from strains.

373. IDENTIFIED CONDUCTORS, CORDS, AND CONNECTORS.

A. Portable Appliances and Devices.

Where portable appliances and devices have cases designed to be grounded and the connecting cable is provided with a separate grounding conductor for this purpose (see rule 371), such grounding conductor and the corresponding parts of connectors shall have suitable identification, so that the grounding conductor in fixed wiring and portable cable will always be connected to the proper terminals of the connectors. Identification of an equipment grounding conductor of a portable cable may be the absence of insulating covering, but if an individual covering is provided for this conductor it shall be finished to show a green color.

Note: If portable cable containing a conductor identified as provided above is not available, the identifying color may be applied to one of the insulated conductors of the cable where the conductor is exposed at terminals.

B. Separable Connectors.

Separable connectors shall be so constructed that wrong connection between the two parts is impossible.

374. USE OF PORTABLES AND PENDANTS.

A. Voltage Limit of Portables.

Portable and pendent conductors shall not be installed or used on circuits operating at more than 300 volts to ground, unless they are accessible only

374. A. Voltage Limit of Portables—Continued.

to qualified persons. In such cases they shall be of a type suited to the voltage and conditions.

In car houses and similar locations where service at low voltage is not available and where necessary to use low-voltage pendent or portable lamps or other equipment in series with lamps on trolley circuits, the equipment should be used only with great caution and be placed preferably on the grounded side of the circuit concerned.

B. **Use of Fixed Receptacles for Portables.**

Where portable conductors are required, fixed receptacles shall be provided at safely accessible points. (See rule 361.)

C. **Hazardous Locations.**

Where exposed to dampness or corrosive influences, portable conductors shall be of a type specially suited, and where exposed to inflammable gas or flyings, they shall be so protected or isolated by elevation that they cannot be readily damaged. In the latter case connectors shall be so arranged as not to be exposed to accidental opening by persons handling the portable conductors or devices. Portable lamps in locations where explosives or inflammable gases are normally present shall be incased in vapor-proof globes with suitable mechanical guards.

Portable lamps in damp places shall be equipped with socket and approved handle of nonabsorptive insulating material, a basket guard, and approved cord.

D. **Strain Relief.**

Portable and pendent conductors shall be so installed that no strain is placed on the terminal connections and shall have no joints except at suitable fittings.

E. **Worn and Defective Portables.**

The use of worn or defective portable and pendent conductors should be avoided because of the danger

374. E. Worn and Defective Portables—Continued.

to users by wire strands piercing the insulation or becoming exposed through abrasion of the covering.

375. PORTABLE OUTDOOR EQUIPMENT OF MORE THAN 750 VOLTS BETWEEN CONDUCTORS.

A. Scope.

This rule is intended to apply to equipment supplied through portable cable and used for such outdoor surface work as well-drilling, strip mining, quarrying, dredging, shoveling, and log sawing.

B. Cables.

1. INSULATION.

Cables, wiring, and electric equipment shall be insulated for not less than line-to-line voltage.

2. TRAILING CABLES.

(a) Trailing cables used for connecting an electric supply to mining machines, dredges, shovels, and similar equipment shall be of sturdy construction and suitable for the intended service.

(b) It is recommended that trailing cables be in continuous lengths. If splices are made they should be equivalent mechanically and electrically to the cable in which they are made.

(c) The individual conductors of trailing cables shall be so connected to equipment and to the source of supply as to give solid and firm connections without injury to the cable and so that the cables cannot be inadvertently disconnected. Such connections shall be weatherproof and there shall be no exposed current-carrying parts.

C. Relays.

Each complete metallic circuit (not separated by insulation as in transformers) shall be equipped with a relay which shall operate on occurrence of a

375. C. **Relays—Continued.**

ground fault on the circuit to deenergize the faulty circuit or equipment.

D. Grounding.

Machinery frames shall be effectively grounded in the manner required by section 9.

E. Impedors.

If it desired to provide protection during the interval of time the fault current exists, the use of an impedor connected between the transformer secondary neutral and the grounding point is recommended. The value of this impedor should be such that the voltage which may occur between the machinery frame and ground will not exceed 100 volts.

376. INSECT ELIMINATORS.

Electric insect eliminators shall be of such low current output as not to be a hazard to persons or property, or they shall be installed and guarded or isolated in accordance with rules 304, C, and 306, A.

SEC. 38. ELECTRICALLY OPERATED INDUSTRIAL LOCOMOTIVES, CARS, CRANES, HOISTS, AND ELEVATORS

380. GUARDING LIVE AND MOVING PARTS.

A. Guarding and Isolation.

All current-carrying parts accessible to unqualified persons which are connected to circuits of more than 150 volts to ground shall be so isolated or guarded that no person can inadvertently come in contact with them.

B. Conductors.

All conductors of more than 150 volts to ground in locations accessible to the public shall be run in conduit, suitable cable, metal molding, or flameproof and waterproof nonmetallic ducts the exposed metallic parts of which shall be effectively grounded.

380. Guarding Live and Moving Parts—Continued.

C. Elevator Hoistways.

Electric conductors installed in or under an elevator or counterweight hoistway shall, except for flexible cables connecting the car with the fixed wiring, be incased in metal conduits or suitable cable and shall be securely fastened to the hoistway. No electrical conduit or cable, except such as is used to furnish or control power, light, heat, or signals for the elevator or hoistway, shall have any opening, terminal, outlet, or junction within the hoistway, but shall be continuous between outlets or terminals situated entirely outside the hoistway.

Note: It is not intended to prohibit the interruption of long runs for the purpose of supporting or pulling in conductors, and pull boxes may be installed for this purpose.

All live parts of electric apparatus in elevator hoistways shall be protected against accidental contact by suitable inclosing casings or coverings, and all such casings or coverings which are made of metal shall be effectively grounded.

No part of any electric circuit having a rated system or circuit voltage in excess of 750 volts dc or 550 volts ac shall be used for any control or operating circuit. No signaling push buttons shall be used in circuits of more than 300 volts to ground. Circuits of higher rated system or circuit voltage may, however, be used in machine rooms or penthouses for the operation of motors, provided that all operating and signal wiring is thoroughly insulated from such power circuits and all machine frames and handropes are effectively grounded.

The maximum system or circuit voltage permitted in the operating devices of automatic-operation elevators having operating devices in the car and at landings shall be 300 volts to ground.

D. Material for Guards.

Guards required by rule 306 and paragraph A of this rule for the current-carrying parts of unisolated electric equipment, such as controllers, motors,

380. D. Material for Guards—Continued.

transformers, fuses, circuit-breakers, switches, and other devices, shall consist of cabinets, casings, or shields of effectively grounded metal or of substantial insulating material, or of a combination of the two. All metallic parts, such as conduits, apparatus cases, etc., which are liable to become charged shall be effectively grounded when so located that unqualified persons may come in contact with them.

E. Apparatus Insulated and Grounded.

On passenger cars, apparatus, such as air-compressor motors, having insulated nongrounded mountings, shall be located where passengers are not liable to come in contact with them, as on the exterior of the car body. The air lines from nongrounded air compressors shall be provided with insulating joints in the line, insulating joints to be located in a substantially vertical pipe run in such a manner as to insulate from the motor all pipe or exposed apparatus with which passengers or crew may come in contact. Such pipe and apparatus shall be grounded.

F. Collector Wires and Third Rail.

Except on fenced rights-of-way or other locations to which only qualified persons are admitted, trolley or crane collector wires and third rails, whether indoors or out, shall be so isolated by elevation (see rule 114 and sec. 23) or be provided with suitable guards so arranged that persons cannot inadvertently touch the current-carrying parts while in contact with the ground or with conducting material connected to the ground.

At locations where unqualified persons are especially exposed to possible contact, warning signs shall be provided.

Trolley-contact conductors, indoors, shall be so supported that, in case of a single break, the lower end of the broken wire will not come within 8 feet of the floor.

Note: Damp wood, concrete floors, and metal parts of crane cabs are considered as connected to ground.

380. Guarding Live and Moving Parts—Continued.

G. Arcing or Suddenly Moving Parts.

All such parts of electric equipment, including fuses and the handles and arc chutes of circuit-breakers, shall be so isolated or guarded that the liability of persons being struck or burned by sparking, flashing, or movement during operation, is avoided.

H. Removable Headlights.

Headlight frames shall not be used as conductors and portable headlights shall be wired for double plug connections. All coupler connections shall be so designed and wired that when the coupler is pulled apart there will be no exposed live parts.

381. GROUNDING NONCURRENT-CARRYING PARTS.

A. Frames.

All noncurrent-carrying metal parts of electric equipment shall be effectively grounded or protected by effectively grounded guards or covers. In electric cars all steam or hot-water heating devices accessible to the public shall also be grounded.

Note: The ground connection through well-bonded track rails will be considered satisfactory for equipment on cars and cranes.

B. Portable Equipment.

The metallic parts of portable cranes, derricks, hoists, and similar equipment on which wires, cables, chains, or other conducting objects are maintained should be provided with an effective protective ground (see sec. 9), where operated in the vicinity of supply lines of more than 150 volts to ground, whether the cranes or similar equipment are themselves electrically operated or not.

On the booms of cranes and derricks mounted on the tracks of railways with overhead trolley-contact conductors, an insulated barrier should be provided which will prevent contact of conducting parts with the overhead wire if the boom is raised against it.

381. Grounding Noncurrent-Carrying Parts—Continued.

C. Guarding Parts on Car Roofs.

Metal parts of car which extend above the car roof (such as whistles or smoke pipes, heater expansion tanks, and metal ventilators) shall either be grounded or insulated or guarded by substantial guards or screens insulated from ground.

If insulated, the insulating joint shall be located immediately below the car roof. Insulating joints in air pipes shall be installed in a substantially vertical run of pipe.

382. CONTROL OF ENERGY SUPPLY TO CARS, CRANES, AND INDUSTRIAL LOCOMOTIVES.

A. Disconnecting Means.

Readily accessible means shall be provided whereby all conductors and equipment, except lightning arresters, located in or on industrial locomotives, cars, or cranes, can be disconnected entirely from the source of energy at a point as near as possible to the trolley or other current collectors; except on such equipments where the current collectors can be readily removed from the trolley or third rail.

B. Main Switch or Circuit-Breaker.

A circuit-breaker or switch, capable of interrupting the circuit under heavy loads, and readily controlled by the operator, shall be provided, unless the current collectors can be safely removed, under heavy loads, from the trolley or third rail.

C. Disconnector for Third-Rail Collector.

Where current supply is from two sources (such as overhead trolley and third rail) disconnecting switches shall be provided as follows:

1. On a public right-of-way, a double-throw switch shall be provided in current-collector cable so arranged that when current supply is from either source, the current-collector cable from the other source is disconnected.
2. On a private right-of-way, a single-throw switch shall be provided in cable to third-rail col-

382. C. Disconnector for Third-Rail Collector—Continued.

lectors so that these may be deenergized when the current supply is from the overhead trolley.

383. CONTROL OF MOVEMENT OF INDUSTRIAL LOCOMOTIVES, CARS, CRANES, AND ELEVATORS.

A. Locking or Removable Handles.

Means shall be provided whereby the operator (whether motorman or elevator attendant) can prevent the starting of the equipment by unauthorized persons while he is absent from his post.

Note: Removable reverse levers or controller handles and locked doors to the operator's cab or elevator hoistway are among the most effective means.

B. Location of Controllers.

The car control lever of passenger elevators should be located so that the operator can readily face the principal car opening. For cars and traveling cranes, the car control should be so located that the operator can readily see in the direction of travel.
It is recommended that the control levers of traveling cranes be located in the same relative position each to the other in all the cages of cranes.

C. Limit Switch.

A limit switch shall be provided for the upper limit of travel of crane hoists and for both upper and lower limits of travel for elevators.
Limit switches shall be at least 4 feet above lowest floor level in garages and other buildings where inflammable gases may be present.

D. Reverse-Phase Relays.

Polyphase alternating-current motors operating freight or passenger elevators or cranes that are dependent upon phase relation for their direction of rotation shall be provided with a device such as a relay, which will prevent starting any motor if the phase rotation is in the wrong direction. In the case of cranes this device may be inserted ahead of the runway feeders.

383. D. Reverse-Phase Relays—Continued.

Exception is made in the case of a control having an operating device for the reversing switches which automatically changes its direction of operation when a change in phase rotation is made in the power circuit.

384. SUBWAY AND CAR LIGHTING.

Subways and similar locations used for passenger transportation where artificial illumination is indispensable shall be lighted throughout their entire length by a system independent of the current for electric traction where such is used. It is recommended that passenger cars operated in such locations and lighted normally from the railway circuit shall be equipped with an auxiliary system of emergency lighting.

SECTION 39. TELEPHONE AND OTHER COMMUNICATION APPARATUS ON CIRCUITS EXPOSED TO SUPPLY LINES OR LIGHTNING

390. PROTECTIVE REQUIREMENTS.

A. General Requirements.

Where telephone or other communication apparatus (not included under (b) below) which must be handled by persons is permanently connected (not including portable telephones) to overhead communication circuits exposed to either lightning, supply lines of more than 400 volts to ground, or induction of more than 150 volts between terminals of the communication equipment and ground from supply circuits under normal conditions, provisions against shock to persons handling apparatus, shall be made by one of the following methods:

1. The use of suitable protective devices such as fuses and arresters operating at 750 volts to ground and, for conditions of unusual exposure, additional devices such as auxiliary arresters, neutralizing transformers, drainage coils or insulating transformers.

390. A. General Requirements—Continued.

2. The grounding of all exposed noncurrent-carrying metal parts and the suitable guarding of all ungrounded current-carrying parts. (See rule 391.)
3. The arrangement of apparatus in such a way that persons using it will be obliged to stand on a suitably insulated platform in a suitably insulated booth, or on other insulating surfaces. (This method may be used only where apparatus is accessible to none but authorized persons.)

B. Fire and Police Alarm Boxes.

Such signaling devices as fire and police alarm and associated test boxes, if connected to overhead communication circuits exposed to lightning or to supply lines of more than 400 volts to ground, should have the accessible noncurrent-carrying metal parts effectively grounded wherever the character of service gives valid objection to the use of arresters or transformers on the signal circuit.

Fire alarm boxes connected to overhead circuits, if not protected by arresters, should be provided with suitable insulating material between the circuit within and the exposed frame and operating hook, this insulation to be capable of withstanding the highest voltage of the supply circuits to which the fire alarm circuit is exposed up to 7,500 volts.

Police alarm boxes, where connected to overhead police alarm circuits, should be protected by arresters, operating at not more than 750 volts, placed in the connecting leads outside the box.

391. GUARDING CURRENT-CARRYING PARTS.

A. Current-Carrying Parts.

Telephone or other communication apparatus which is permanently located outdoors or where exposed to corrosive fumes or dampness (such as may occur in subways, cellars, basements, laundries, stables, etc.) shall be so arranged that all ungrounded

391. A. Current-Carrying Parts—Continued.

current-carrying parts are so guarded as to be suitably protected against the prevailing atmospheric conditions.

The inclosing cases of communication apparatus provide suitable guards if substantially built of metal or insulating materials.

B. Receiver Cords.

Receiver cords where required to be guarded shall be guarded by shields of effectively grounded metal (such as metal armor) or of nonabsorptive insulating material (such as flexible insulating tubing) or suitable insulating coverings for the individual conductors. (See 390, A, 2.)

C. Shields for Portable Cords.

Where no protective device is installed the shields of portable cords shall always be of grounded metal or of special insulating material suitable to withstand the voltage of the highest-voltage supply circuit to which the communication circuit is exposed up to 7,500 volts.

392. GROUNDING.

The ground connections for outside installations of cable protectors employed solely to prevent electrical damage to the cable need not conform with the requirements of this rule.

A. Methods.

Arresters and, where required, exposed non-current-carrying metal parts shall be grounded in the following manner:

1. The grounding conductor shall preferably be of copper (or other material which will not corrode excessively under the prevailing conditions of use) and shall be not less than No. 18 (0.040 inch) in size, and where within buildings shall be covered with a suitable insulation.

392. A. Methods—Continued.

If necessary to guard the grounding conductor from mechanical damage (on poles or where a grounding conductor on the outside of building walls is near a roadway, sidewalk, or pathways, thus exposing it to tampering by unauthorized persons), it shall be protected for a distance of 8 feet from the ground by a wooden molding or by conduit of nonmagnetic material.

2. The grounding conductor shall preferably be connected to a cold-water pipe. In the absence of a water pipe, connection may be made to a continuous underground metallic gas-piping system, to metallic structures when effectively grounded, or to a ground rod or pipe driven into permanently damp earth. If a gas-pipe electrode is used, connection shall be made between the gas meter and the street main. Steam or hot-water pipes should not be used for ground connections. Driven rods or driven pipes used as ground connections for protectors shall not be also used as ground connections for electric-supply circuits or electric apparatus. The requirement of separate driven rods or pipes for protectors and for electric supply circuit grounding, or the use of other separate grounds, does not prohibit bonding together such grounds where such bonding seems desirable. Where water or gas pipes are used for a ground connection, attachment to such pipes shall not be made at the same point as attachments to electric-supply circuits or equipment.

B. Connecting Grounding Conductor to Pipes.

Grounding conductors shall be attached to pipes by means of suitable ground clamps; the entire surface of the pipe to be covered by the clamp shall be thoroughly cleaned.

392. Grounding—Continued.

C. Connecting Grounding Conductors to Driven Rod or Pipe or Other Metallic Structure.

Grounding conductors shall be so attached to the rod, pipe or metallic structure as to give reliable connection, both mechanically and electrically, and in such a manner as to prevent excessive corrosion when the joint is buried in the earth.

PART 4. RULES FOR THE OPERATION OF ELECTRIC EQUIPMENT AND LINES

CONTENTS

Page

Sec. 40. Scope and application 307
- 400. Scope 307
- 401. Application 307
- 402. Exposed communication lines 308

Sec. 41. Supply systems—Rules for employers 308
- 410. General requirements 308
- 411. Protective methods 311

Sec. 42. Supply systems—General rules for all employees 313
- 420. General precautions 313
- 421. Operating routines 317
- 422. Handling live equipment or lines 322
- 423. Killing equipment or lines 327
- 424. Making protective grounds 330

Sec. 43. Supply systems—Rules for employees doing specialized work 331
- 430. Supply stations and switchboards 331
- 431. Meters 334
- 432. Testing 335
- 433. Overhead lines 336
- 434. Series street lamps 339
- 435. Communication circuits used in connection with supply lines 341
- 436. Underground lines 342
- 437. Tunnel and subway 344

Sec. 44. Communication systems—Rules for employers 347
- 440. Distribution and enforcement of rules 347
- 441. Address list and emergency rules 348
- 442. Instructing employees 348
- 443. Qualification of employees 349
- 444. Protective devices 349

Sec. 45. Communication systems—Rules for employees 349
- 450. General precautions 349
- 451. Overhead lines 352
- 452. Underground lines 356

SEC. 40. SCOPE AND APPLICATION

400. Scope.

A. Sections 41 to 43.

The safety rules in sections 41, 42, and 43 do not apply to new construction not yet energized, but apply to the operation of, or to work on or about, the following:

1. Supply lines.
2. Communication lines used in connection with supply lines.
3. Electric equipment of central stations, substations, and private plants.
4. Electrical tests.
5. Electrical work in tunnel, subway, or similar underground structures.

B. Sections 44 and 45.

The safety rules in these sections apply to commercial telephone and telegraph, and other communication equipment and lines, with terminology adapted to the special needs of the employees concerned. Communication equipment and lines include fire- and police-alarm systems, district-messenger systems, and other communication systems not operated in connection with supply lines.

401. Application.

While all the rules find application in the larger industrial or private plants and in moderate-sized utilities, some do not apply, or apply less fully, in the smaller ones. It has seemed unwise, however, to attempt to restrict the scope of these rules to rules which are applicable to all organizations or to all classes of electrical work.

402. EXPOSED COMMUNICATION LINES.

Communication equipment and lines are not considered alive, except where made alive by leakage from supply equipment or lines. They are, however, a source of danger when near live supply conductors on wood poles, due to their liability of being grounded.

SEC. 41. SUPPLY SYSTEMS—RULES FOR EMPLOYERS

410. GENERAL REQUIREMENTS.

A. Interpretation and Enforcement of Rules.

1. DISTRIBUTION.

The employer shall furnish to each regular employee operating or working on electric supply equipment, supply or communication lines, or hazardous electrical tests a copy of these safety rules for operation (or such of these rules as apply to his work), either separately or incorporated in more comprehensive rule books, and shall take means to secure the employee's compliance with the same.

Note: Many companies number their books of rules and require a receipt from each employee for his copy.

2. INTERPRETATION.

If a difference of opinion arises with regard to the meaning or application of these rules or as to the means necessary to carry them out, the decision of the employer or his authorized agent shall be final, unless an appeal is taken to the regulatory body having jurisdiction.

3. MODIFICATION.

Cases may arise where the strict enforcement of some particular rule will seriously impede the progress of the work in hand; in such cases the employee in charge of the work to be done may, with the consent of the chief operator concerned, make such temporary modification of the rule as will expedite the work without materially increasing the hazard.

410. General Requirements.—Continued.

B. Organization Diagram.

An organization diagram or written statement clearly showing the division of responsibility between officials and employees, down to and including the grade of foreman, should be supplied with the book of rules, or the diagram should be posted conspicuously in offices and stations of the employer and in other places where the number of employees and the nature of the work warrants.

C. First-Aid Rules and Physicians' Addresses.

The rule book should contain or be accompanied by the following:

1. A list of names and addresses of those physicians and members of the organization who are to be called upon in emergencies.
2. A copy of rules for first aid, prone-pressure method of resuscitation, and fire extinguishment. These should also be kept in conspicuous locations in every station and testing room, in line wagons, and in other places where the number of employees and the nature of the work warrants.

D. Instructing Employees.

Employees regularly working on or about equipment or lines shall be thoroughly instructed in methods of first aid, resuscitation by the prone-pressure method, and where advisable in fire extinguishment.

E. Qualifications of Employees.

The employer shall use every reasonable means and precaution to assure himself that each employee is mentally and physically qualified to perform his work in accordance with these rules.

F. Chief Operator.

1. AUTHORITY.

A properly qualified chief operator, system operator, load dispatcher, general superintend-

410. F. Chief Operator—Continued.

ent, or otherwise designated employee shall be in charge of the operation of electric equipment and lines and directly responsible for their safe operation. His duties shall be those prescribed in rule 421, A.

2. DEPUTY.

In large organizations the duties of the chief operator may be delegated for any particular section of the system to a deputy chief operator (or otherwise designated employee) who shall report as required to the chief.

3. LARGE ORGANIZATIONS OR EXTENDED SYSTEMS.

When it is impracticable to have the entire system placed in charge of one chief operator, the duties of the chief operator may be performed by a local superintendent, local manager, or other employee who may also perform other duties.

4. SMALL ORGANIZATIONS.

The duties of the chief operator in small organizations may be performed for a portion of the system by a local superintendent, electrician, engineer, or some other employee who may also perform other duties.

Note: In these rules the various employees listed by above titles, including the deputy chief operator, will be designated (for simplicity) by the title of chief operator, where referred to in this capacity.

G. Responsibility.

If more than one person is engaged in work on or about the same electric equipment or lines at any one location, one of the persons shall be designated as the foreman locally in charge of the work; or, all of the workmen shall be instructed as to the work they are to perform, and the employee instructing the workmen shall be considered in charge of the work.

411. PROTECTIVE METHODS.

A. Attendance.

Unless a qualified employee is kept on duty where generators or rotary converters are operating, such equipment shall be made inaccessible to unauthorized persons.

B. Requirement for Two Workmen.

In wet weather or at night, no employee shall work alone on or dangerously near live conductors or parts of overhead or underground lines of more than 750 volts between conductors.

Exception: Trouble or emergency work is excepted.

C. Unqualified Workmen and Visitors.

Unqualified employees or visitors shall be prohibited from approaching any live parts, unless accompanied by a qualified employee, who should warn the unqualified employee or visitor of the danger attendant upon such approach.

D. Diagrams for Chief Operator.

Diagrams or equivalent devices, showing plainly the arrangement and location of the electric equipment and lines, should be maintained on file or in sight of the chief operator.

Note: These diagrams may be of the entire system, or of each specific portion of the system, or they may show typical arrangements.

E. Instructions to Employees.

All employees shall be instructed as to the character of all equipment or lines on or dangerously near to which work must be done by them. Instructions shall describe the equipment and lines to be worked on, identifying them either by position, letter, color, number, or name.

F. Protective Devices.

A supply of suitable protective, first-aid, and fire-extinguishing devices and equipment, sufficient to enable employees to meet the requirements of these

411. F. Protective Devices—Continued.

rules, shall be provided in conspicuous and suitable places in electrical stations, testing departments, and line construction and repair wagons.

The following is a list of suitable devices and equipment, the kinds and numbers of which will depend on the requirements of each case:

1. First-aid outfits.
2. Insulating wearing apparel, such as insulating gloves, sleeves, and boots. Insulating shields, covers, mats, stools, and platforms. Insulating appliances, such as rods and tongs, for any necessary handling or testing of live equipment or lines.
3. Protective goggles of suitable materials and construction.
4. Tools of such special design and insulation as to eliminate so far as practicable the danger of forming short-circuits across conducting parts at different potentials or bringing the user into contact with such parts.
5. "Men at work" tags, log books, operation diagrams, or equivalent devices, and portable danger signs.
6. Fire-extinguishing devices, either designed for safe use on live parts or plainly marked that they must not be so used.
7. Grounding devices for making protective grounds.
8. Fixed or portable lighting equipment.

G. Inspection of Protective Devices.

Protective devices and equipment shall be inspected or tested to insure that they are kept in good order and in dependable condition and shall not be used unless so inspected, and, in the case of insulating devices, tested as frequently as their use necessitates. Safety belts, whether furnished by employer or employee, should be inspected from time to time to assure that they are in safe working condition.

411. Protective Methods—Continued.

H. Warning Signs.

Permanent warning signs forbidding entrance to unauthorized persons shall be displayed in conspicuous places at all unattended and unlocked entrances to electrical supply stations, substations, and testing rooms containing exposed current-carrying parts or moving parts.

I. Danger Signs.

Suitable danger signs shall be placed in supply stations, substations, switching towers, and testing rooms about equipment having exposed current-carrying parts of more than 750 volts between conductors.

J. Identification.

Circuits should be tagged, marked, or lettered unless identification can be obtained by location.

SEC. 42. SUPPLY SYSTEMS—GENERAL RULES FOR ALL EMPLOYEES

420. General Precautions.

A. Rules and Emergency Methods.

The safety rules should be carefully read and studied. Employees may be called upon at any time to show their knowledge of the rules.

Employees should familiarize themselves with approved methods of first-aid, resuscitation, and fire extinguishment.

B. Heeding Warnings, Warning Others.

Employees whose duties do not require them to approach or handle electric equipment and lines should keep away from such equipment or lines.

They should cultivate the habit of being cautious, heeding warning signs and signals, and always warning others when seen in danger near live equipment or lines.

420. B. Heeding Warnings, Warning Others—Continued.

An employee should report as soon as practicable to his superior or some suitable authority any obvious hazards to life or property observed in connection with any electric equipment or lines.

Any imminently dangerous conditions shall be guarded until they can be made safe.

C. Inexperienced or Unfit Employees.

1. No employee shall do work for which he is not properly qualified on or about live equipment or lines.

Exception: Work done under the direct supervision of an experienced and properly qualified person is excepted.

2. If an employee is in doubt as to the proper performance of any work assigned to him, he should request instructions from the foreman or other responsible person.

D. Supervision of Workmen.

Workmen, whose employment incidentally brings them in the vicinity of electric supply equipment or lines with the dangers of which they are not familiar, shall proceed with their work only when authorized. They shall then be accompanied by a properly qualified and authorized person, whose instructions shall be strictly obeyed.

E. Exercising Care.

Employees near live equipment and lines should consider the effect of each act and do nothing which may endanger themselves or others. Employees should be careful always to place themselves in a safe and secure position and to avoid slipping, stumbling, or moving backward against live parts. The care exercised by others should not be relied upon for protection.

420. General Precautions—Continued.

F. Live and Arcing Parts.

1. TREAT EVERYTHING AS ALIVE.

Electric equipment and lines should always be considered as alive, unless they are positively known to be dead. Before starting to work, preliminary inspection or test should always be made to determine what conditions exist. (See rule 422, A, for general requirements and rule 424, C, for test of circuit.)

2. PROTECTION AGAINST ARCS.

The hands should be covered by protecting and insulating gloves and the eyes by suitable goggles or other means if exposed to injurious arcing. Either a thin rubber glove used with a protective outer glove or a heavier rubber glove used alone shall be considered as both protecting and insulating.

Employees should keep all parts of their bodies as far away as possible from brushes, commutators, switches, circuit-breakers, or other parts at which arcing is liable to occur during operation or handling.

G. Safety Appliances.

Employees at work on or near live parts should use the protective devices and the special tools provided. Before starting work these devices or tools should be examined to make sure that they are suitable and in good condition.

Note: Protective devices may get out of order or be unsuited to the work in hand.

H. Suitable Clothing.

Employees should wear suitable clothing while working on or about live equipment and lines. In particular, they should keep sleeves down and avoid wearing unnecessary metal or inflammable articles, such as rings, watch or key chains, or metal cap visors, celluloid collars, or celluloid cap visors. Loose clothing and shoes that slip easily should not be worn near moving parts.

420. General Precautions—Continued.

I. Safe Supports.

Employees should not support themselves on any portion of a tree, pole structure, scaffold, ladder, or other elevated structure without first making sure that the support is strong enough. Supports should be reinforced if necessary.

Conducting paint should not be used in painting portable ladders. Portable ladders should not be reinforced longitudinally with metal when used in electrical stations.

Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the supporting surfaces are smooth or vibrating.

J. Safety Belts.

Employees working in elevated positions should use a suitable safety belt or other adequate means to guard against falling. Before an employee trusts his weight to the belt, he should determine that the snaps or fastenings are properly engaged and that he is secure in his belt. No safety belt or other protective device shall be used that has not been approved and recently tested as provided in rule 411, G.

K. Fire Extinguishers.

In fighting fires near exposed live parts, employees should avoid using fire-extinguishing liquids which are not insulating. If necessary to use them, all neighboring equipment should first be killed.

L. Repeating Messages.

Each person receiving an unwritten message concerning the handling of lines and equipment shall immediately repeat it back to the sender and secure his full name and acknowledgment. Each person sending an unwritten message shall require it to be repeated back to him by the receiver and secure the latter's full name.

421. OPERATING ROUTINES.

A. Duties of Chief Operator.

The chief operator, described in rule 410, F, shall—

1. Keep informed of all conditions affecting the safe and reliable operation of the system.
2. Keep a suitable record or log book showing all changes in such conditions. He shall read and sign such record when assuming duty and sign again on being relieved.
3. Keep within sight operating diagrams or equivalent devices indicating whether electric supply circuits are open or closed at stations under his immediate jurisdiction, and where work is being done under his special authorization.

   Exception: These indicating devices shall not be required for any chief operators classed under paragraphs 3 and 4 of rule 410, F, if the record or log sheets show all conditions affecting the safe and reliable operation of the system.

Note: In these rules the person performing these duties is designated as chief operator, regardless of his ordinary title.

B. Duties of Foreman.

Each foreman in charge of work shall adopt such precautions as are within his power to prevent accidents and to see that the safety rules are observed by the employees under his direction. He shall make all the necessary records, and shall report to his chief operator when required. He shall, as far as possible, prevent unauthorized persons from approaching places where work is being done. He shall also prohibit the use of any tools or devices unsuited to the work in hand or which have not been tested as provided in rule 411, G.

[NOTE.—Subsequent to the publication of Part 4, the limit of the voltage classification was increased from 7,500 to 8,700 volts by the Sectional Committee in revising Part 2 of this edition of the code.]

421. Operating Routines—Continued.

C. Qualified Guides.

The qualified persons accompanying uninstructed workmen or visitors near electric equipment or lines shall take precautions to provide suitable safeguards and see that the safety rules are observed.

D. Special Authorization.

1. SPECIAL WORK.

Special authorization from the chief operator shall be secured before work is begun on or about station equipment, transmission, or interconnected feeder circuits or live circuits of more than 7,500 volts* between conductors, and in all cases where circuits are to be killed by regular procedure at stations, and a report shall be made to him when such work ceases.

Exception: In emergency, to protect life or property, or when communication with the chief operator is difficult, because of storms or other causes, any qualified employee may make repairs on or about the equipment or lines covered by this rule without special authorization if the trouble is such as he can promptly clear with help available in compliance with the remaining rules. The chief operator shall thereafter be notified as soon as possible of the action taken. (See rule 421, H, 2, for crossed or fallen wires.)

2. OPERATIONS AT STATIONS.

In the absence of specific operating schedules for opening and closing supply circuits at stations, or starting and stopping equipment, employees shall secure special authorization from the chief operator before performing these operations. In all cases such special authorization shall be secured where circuit or equipment control devices are tagged at stations to protect workmen. (See rule 421, F, for tagging electric circuits.)

---

*See note on page 317.

421. D. 2. Operations at Stations—Continued.

Exception: In emergency, to protect life or property, any qualified employee may open circuits and stop moving equipment without special authorization if, in his judgment, his action will promote safety, but the chief operator shall be notified as soon as possible of such action, with reasons therefor. To maintain service, any qualified employee may also reclose circuits which have been opened by fuses or automatic circuit-breakers except where this is prohibited by rule.

3. CUTTING OFF SECTIONS OF CIRCUITS.

Special authorization shall be secured from the chief operator before sections of overhead or underground circuits are cut off by employees at points other than at stations by means of sectionalizing switches.

Exception: Portions of distribution circuits of less than 7,500 volts* between conductors may be cut off by authorized employees without special authorization from the chief operator, by means of sectionalizing switches, if the chief operator is thereafter notified as soon as possible of the action taken. This may also be done even for circuits of more than 7,500 volts* when communication with the chief operator is difficult.

E. Restoring Service After Work.

Instructions for making alive equipment or lines which have been killed by permission of the chief operator to protect workmen shall not be issued by him until all workmen concerned have been reported clear. When there is more than one workman at a location, a person authorized for the purpose shall report clear for such workmen, but only after all have reported clear to him. If there is more than one gang, each shall be so reported clear to the chief operator.

---

*See note on page 317.

421. Operating Routines—Continued.

F. Tagging Electric Supply Circuits.

1. WHEN TAGS ARE PLACED AT DIRECTION OF CHIEF OPERATOR.

Before work is done at direction of chief operator on or about equipment or circuits, under any of the conditions listed below, the chief operator shall have "Men at work" tags attached at all points, where such equipment or circuits can be manually controlled by regular operators. The tags should be placed to plainly identify the equipment or circuits worked on.

(a) Transmission or interconnected feeder circuits.

(b) Circuits operating at more than 7,500 volts* between conductors.

(c) Circuits killed at stations and substations to protect workmen.

2. WHEN TAGS ARE PLACED AT DIRECTION OF AUTHORIZED EMPLOYEES.

Before work is done on or about any equipment or lines which are killed by authorized employees at points other than at stations, the employees shall have "Men at work" tags placed at all points where the circuit has been disconnected to identify the portion worked on.

G. Maintaining Service.

1. CLOSING TAGGED CIRCUITS WHICH HAVE OPENED AUTOMATICALLY.

When live circuits on which "Men at work" tags have been placed have opened automatically, they should be kept disconnected until the chief operator has given proper authorization for reconnection.

2. CLOSING CIRCUITS OPENED AUTOMATICALLY.

When overhead circuits, other than trolley and third-rail circuits, open automatically, the employer's local operating rules shall determine in what manner and how many times they may be

---

*See note on page 317.

421. G. 2. Closing Circuits Opened Automatically—Contd.

closed with safety for persons on or near those circuits. The chief operator shall be informed of the conditions.

3. GROUNDED CIRCUITS.

When circuits feeding supply lines become accidentally grounded, they shall be tested to determine where the ground exists. If the ground can not be definitely located and removed by the station operator, an immediate report of the finding shall be given to the chief operator, who shall order a patrol of the lines affected to definitely locate and remove the ground as soon as practicable.

Note: On circuits exceeding 7,500 volts* between conductors, it will usually be found advisable to disconnect the circuit or effectively ground the accidentally grounded conductor until the lines have been cleared of the accidental ground.

H. Protecting Traffic.

1. BARRIER GUARDS.

Employees shall first erect suitable barrier guards before engaging in such work as may endanger traffic. They shall also display danger signs or red lamps placed so as to be conspicuous to approaching traffic. Where the nature of work and traffic require it, a man shall be stationed to warn passers-by while work is going on.

2. CROSSED OR FALLEN WIRES.

An employee finding any crossed or fallen wires which may create a hazard shall remain on guard or adopt other adequate means to prevent accidents, and shall have the chief operator notified. If the employee can observe the rules for handling live parts by the use of insulating appliances, he may correct the condition at once; otherwise he shall first secure the authorization from the chief operator for so doing. (See rule 421, D, for special authorization.)

---

*See note on page 317.

421. Operating Routines—Continued.

I. Protecting Workmen by Switches and Disconnectors.

When equipment or lines are to be disconnected from any source of electric energy, for the protection of workmen, the operator shall first open the switches or circuit-breakers designed for operation under load, and then the air-break disconnectors, when provided.

422. HANDLING LIVE EQUIPMENT OR LINES.

A. General Requirements.

1. TOUCHING LIVE PARTS.

An employee should never touch with bare hands two parts at different potentials at the same time. He should never touch with bare hands even a single exposed ungrounded live part at a dangerous potential to ground unless he is insulated from other conducting surfaces, including the ground itself, and stands on insulating surfaces.

2. WIRE INSULATION.

Employees should not place dependence for their safety on the insulating covering of wires.

All precautions in this section for handling live parts shall be observed in handling covered wires.

Note: Covering or insulation on a wire may look perfect, but frequently it will not prevent shock.

3. EXPOSURE TO HIGHER VOLTAGES.

Every employee working on or about equipment or lines exposed in overhead construction to voltages higher than those guarded against by the safety appliances provided should as far as practicable assure himself that the equipment or lines worked on are free from dangerous leakage or induction or have been effectively grounded.

4. CUTTING INTO INSULATING COVERINGS OF LIVE CONDUCTORS.

When the insulating covering on live wires or cable must be cut into, the employee should use a suitable tool.

422. A. 4. Cutting Into Insulating Coverings—Contd.

Recommendation: While doing such work, it is recommended that suitable goggles be worn to protect the eyes, and insulating gloves to protect the hands.

When metal sheathing must be removed from cables, it should be done with special tools which will not injure the insulation. The sheathing should be cut so as to leave enough exposed insulation after the conductor has been bared to avoid arcing over between the conductor and the sheath. If the cable consists of more than one conductor, similar exposed insulating surface should be left for each conductor, using insulating separators between conductors, if necessary.

Insulating devices, such as wood separators, etc., should be examined, and conducting dust or chips, sharp edges, or nails should be eliminated to avoid defeating the purpose for which the devices are intended.

5. METAL TAPES OR ROPES.

Metal measuring tapes, and tapes, ropes, or hand lines having metal threads woven into the fabric should not be used near exposed live parts.

6. METAL-REINFORCED LADDERS.

Ladders reinforced by metal in a longitudinal direction should not be used near exposed live parts.

B. Voltages Between 750 and 7,500.*

No employee should go, or take any conducting object without a suitable insulating handle, within 6 inches of any exposed live part whose voltage exceeds 750 volts to ground, where it is practicable to avoid this.

Where safe distance from live parts cannot be secured by use of the special insulating tools and appliances furnished, properly tested insulating gloves, shields, mats, covers, and sleeves may serve as the sole portable insulating devices between the person and live parts.

---

*See note on page 317.

422. B. Voltages Between 750 and 7,500*—Continued.

Exception 1: In dry locations this distance may be less than 6 inches, if insulating devices, such as shields, covers, or gloves are placed between the person and the part or object.

Exception 2: In dry locations, the distance may also be reduced if insulating barriers (such as mats, stools, or platforms) are placed between the person and the ground, and suitable insulating shields between the person and all other conducting or grounded surfaces, which he could accidentally touch at the same time.

Exception 3: In all damp or dark locations, the distance may be less than 6 inches only if insulating devices are used between the person and the live parts and also between him and all other conducting surfaces with which he might otherwise come in contact at the same time.

Note: Care should be exercised in using insulating gloves to avoid puncturing them on sharp edges, especially in making wire splices. It is sometimes advisable to wear protecting gloves over insulating gloves.

Under some circumstances it is desirable to cover with protective insulating material any grounded conductor or other grounded metal adjacent to work on live conductors, where the lineman might inadvertently contact it while handling a live conductor.

C. Voltages Exceeding 7,500. *

1. CLEARANCES FROM LIVE PARTS.

No employee should go, or take any conducting object, within the distances named below from any exposed live part at or above the voltage specified.

Clearance from Live Parts

Operating voltage:	Distance in feet
7,500*	1
15,000	2
50,000	3
70,000	5

---

*See note on page 317.

422. C. Voltages Exceeding 7,500*—Continued.

Distances for intermediate voltages to be determined by interpolation.

Exception: In dry locations these distances may be reduced if suitable insulating guards or barriers are placed between the person and such part or object.

2. GUARDS.

If the part is being directly worked on, the tools or other mechanical appliances used shall have insulating handles of sufficient length to permit the operator to maintain the distance specified in rule 422, C, 1, preceding.

Exception: This does not apply if protective guards are also used between the person and the live part.

Note: These protective guards may be permanent insulating covers or shields, or may be disks of insulating material, suitable for the voltages to be handled and for the attendant conditions, attached to the handles of rods or tools.

D. Requirement for Two Workmen.

In wet weather or at night no employee shall work alone on or dangerously near live conductors or parts of more than 750 volts between conductors.

Exception: Trouble and emergency work is excepted.

E. When to Kill Parts.

An employee shall not approach, or willingly permit others to approach, any exposed ungrounded part normally alive closer than permitted by rule 422, A, B, or C, unless the supply equipment or lines are killed.

Note: This is to ensure the employee of his own safety and the safety of those working under his direction.

F. Opening and Closing Switches.

Manual switches and disconnectors should always be closed by a single unhesitating motion, and, if

---

*See note on page 317.

422. F. Opening and Closing Switches—Continued.

possible, with one hand. Care should be exercised in opening switches to avoid causing serious arcing.

G. Work from Below.

Employees should avoid working on equipment or lines from any position by reason of which a shock or slip will tend to bring the body toward exposed live parts. Work should, therefore, generally be done from below, rather than from above.

H. Attaching Connecting Wires and Grounds.

1. HANDLING CONNECTING LINES.

In connecting dead equipment or lines to a live circuit by means of a connecting wire or device, employees should first attach the wire to the dead part before attaching it to the circuit. When disconnecting, the live end should be removed first. Loose conductors shall be kept away from exposed live parts.

2. APPLYING GROUNDS.

In applying a grounding device to normally live parts, the device shall be grounded before being brought near the parts and shall be removed from the live parts before being removed from the ground connection.

I. Handling Series Circuits.

Secondaries of current transformers to meters or other devices should not be opened when alive until a jumper has been connected across the point of opening or the circuit has been short-circuited elsewhere.

Before working on arc lamps connected to series circuits, they shall be short-circuited or (when necessary to avoid hazard) disconnected entirely from such circuits by absolute cutouts.

J. Stringing Wires.

In stringing wires near live conductors, the wires being strung should be treated as alive unless they are effectively grounded.

423. KILLING EQUIPMENT OR LINES.

A. Application of Rule.

If workmen must depend on others for operating switches to kill circuits on which they are to work, or must secure special authorization from the chief operator before themselves operating such switches, the following precautionary measures shall be taken in the order given before work is begun on or about the equipment or lines concerned as a means for preventing misunderstanding and accident:

In small organizations the chief operator may himself operate the switches and disconnectors instead of instructing others to do so, thus much simplifying and abbreviating the procedure. In certain cases the chief operator may direct the workman who wishes the section killed for his own protection to operate some or all switches necessary himself, thus also abbreviating the procedure.

In cases where there is no station with regular attendants at either end of a section of line to be killed for the protection of workers, the rules below need not apply for disconnection of that end of the section concerned, provided that the employee under whose direction that end of the section is disconnected is in sole charge of the section and of the means of disconnection employed or that the point of disconnection at that end of the section is suitably tagged before work proceeds.

B. Workman's Request.

The workman in charge of the work shall apply to the chief operator to have the particular section of equipment or lines killed, identifying it by position, letter, color, number, or other means.

C. Opening Disconnectors and Tagging.

The chief operator, at his discretion, shall direct the proper persons to open all switches and air-break disconnectors through which electric energy may be supplied to the particular section of equipment and lines to be killed, and shall direct that such

423. C. Opening Disconnectors and Tagging—Continued.

switches and disconnectors be tagged with a tag of a distinctive character indicating that men are at work. All oil switches and remotely controlled switches should also be blocked where necessary for avoiding mistakes.

A record shall be made when placing the tag giving the time of disconnection, the name of the man making the disconnection and the name of the workman who requested the disconnection, and the name of the chief operator.

Where the section of equipment or lines can be made alive from two or more sources, all such sources shall be disconnected.

Note: This will apply to work on lines with more than one station; also sometimes to work on transformers in banks, rotary converters, motor-generators, switches, and on other similar equipment.

D. Station Protective Grounds.

When all the switches and disconnectors designated have been opened, blocked, and tagged in accordance with rule 423, C, the chief operator shall require that protective grounds be made upon the circuits which have been killed and that they are reported to him when placed.

Exception: This requirement does not apply under conditions where the making of such grounds or the conditions resulting from having made the grounds would be more hazardous than working on lines without grounding.

E. Permission to Work.

Upon receipt of information from all persons operating switches and disconnectors that protective grounds are in place, the chief operator shall inform the workman who requested the killing of the section that the specified section of equipment or line has been killed and that he may proceed to work.

F. Workmen's Protective Grounds for Overhead Lines.

The workman in charge should immediately proceed to make his own protective grounds on the discon-

423. F. Workmen's Protective Grounds—Continued.

nected lines, except under conditions where the making of such grounds or the conditions resulting therefrom would be more hazardous than working on the lines without grounding. Such grounds shall be made between the particular point at which work is to be done and every source of energy.

G. Proceeding with Work.

After the equipment or lines have been killed (and grounded, if required by F above), the workman in charge and those under his direction may proceed with work on the grounded or killed parts. Care, however, shall be taken to guard against adjacent live circuits or parts.

H. Procedure for Other Gangs.

Each additional workman in charge desiring the same equipment or lines to be killed for the protection of himself or the men under his direction shall follow the same procedure as the first workman and secure similar protection.

I. Reporting Clear—Transferring Responsibility.

The workman in charge, upon completion of his work, and after assuring himself that all men under his direction are in safe positions, shall remove his protective grounds and shall report to the chief operator that all tags protecting him may be removed, and shall give his location and report as follows: "Mr. ——— and men clear and all grounds removed."

The workman in charge who received the permission to work may transfer this permission and the responsibility for men under him, as follows:

He shall personally inform the chief operator of the proposed transfer, and if this is permitted, the name of the successor shall be entered at that time on the tags concerned or in the records of the persons placing the tags and of the chief operator. Thereafter

423. I. Reporting Clear—Transferring Responsibility—Con.

the successor shall report clear and shall be responsible for the safety of the original workmen, so far as this is affected by the removal of tags.

J. Removal of Tags.

The chief operator shall then direct the removal of tags for that workman and the removal shall be reported back to him immediately by the persons removing them. Upon the removal of any tag, there shall be added to the record the name of the chief operator and workman who requested the tag, the time of removal, and the signature of the person removing the tag.

K. Restoring Service.

Only after all protecting tags have been removed by the above procedure from all points of disconnection shall the chief operator, at his discretion, direct the removal of protective grounds and blocks and the closing of any or all disconnectors and switches.

424. MAKING PROTECTIVE GROUNDS.

A. Application of Rule.

When making temporary protective grounds on a normally live circuit, the following precautionary measures shall be observed in the order given, and the ground shall be made to all wires of the circuit which are to be considered as grounded.

B. Ground Connections.

The employee making a protective ground on equipment or lines shall first connect one end of grounding device to an effective ground connection supplied for the purpose.

C. Test of Circuit.

The normally live parts which are to be grounded should next be tested for any indication of voltage, the employee carefully keeping all portions of his

424. C. Test of Circuit—Continued.

body at the distance required from such parts when alive by the use of suitable insulating rods or handles of proper length, or other suitable devices.

D. Completing Grounds.

If the test shows no voltage, or the local operating rules so direct, the free end of the grounding device shall next be brought into contact with the normally live part and securely clamped or otherwise secured thereto before the employee comes within the distances from the normally live parts specified in rule 422, B and C, or proceeds to work upon the parts as upon a grounded part.

In stations, remote-control switches can sometimes be employed to connect the equipment or lines being grounded to the actual ground connection. On lines it is generally necessary to resort to portable grounding devices or chains handled directly by means of insulating handles, rods, or ropes.

E. Removing Grounds.

In removing a protective ground the employee shall not remove the grounding device from the ground connection until the device has been disconnected from all normally live current-carrying parts.

SEC. 43. SUPPLY SYSTEMS—RULES FOR EMPLOYEES DOING SPECIALIZED WORK

430. Supply Stations and Switchboards.

A. Application of Rule.

Engineers, machine attendants, switchboard operators, and helpers shall study and strictly observe the following, in addition to all the general rules 420 to 424 which apply to their work.

B. Care About Machines.

Do not allow oil cans, tools, dusters, or wiping cloths to catch in moving parts of machinery. In

430. B. Care about Machines—Continued.

passing any switchboard or machine in operation, do not touch it unnecessarily nor allow metal tools or other metal objects to touch the apparatus or connections. Do not use iron or tin oil cans near field magnets, and use only dusters and wipers with insulating handles on or about exposed live parts. Employees about to work on normally moving parts of remotely controlled equipment during periods of rest, shall be protected against their accidental starting by "Men at work" signs first being placed on the starting devices, and by locking or blocking these where practicable. All employees shall, before starting any work, satisfy themselves that all these protective devices have first been installed. (See rule 423.)

Do not use a metal bar to turn over the rotor of any energized machine. Do not use a metal rule or tape or metal-reinforced fabric tape near live circuits. Do not use air hose with metallic covering or fittings around live electric apparatus or conductors. Do not use a flashlight with metal case near live parts.

C. Care Near Live or Moving Parts.

Do not work on or near exposed live or moving parts unless authorized to do such work, and then strictly observe the rules applying.

When working near fuses and circuit-breakers or other apparatus which may arc suddenly, be careful to avoid injury from their operation.

When working on one section of a switchboard or in one compartment, mark it conspicuously and place barriers to prevent your accidental contact with live parts in that section or adjacent sections.

When working on or near live parts and standing on insulated stools or ladders, or when otherwise insulated from the ground, avoid handing metal tools or other objects to other persons who are not insulated.

430. C. Care Near Live or Moving Parts—Continued.

Do not stand on, sit on, or pass through belts, whether the belt is at rest or in motion.

D. Handling Fuses or Brushes.

In handling fuses of more than 750 volts, use special rods or tongs and stand on insulating platforms or mats, where provided. Keep the body as distant and as far below as possible.

Replace or remove link fuses from live terminals and handle brushes on live equipment only when absolutely necessary, and then with due precautions.

E. Battery Rooms.

Smoking, or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided, as they may ignite the gas if discharged close to its source, as at the vent of a sealed-type cell during overcharging.

The electrolyte of storage batteries, and spray containing electrolyte, are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothes should be avoided.

Do not handle live parts of batteries or their connections unless adequate precautions are taken to avoid shock.

F. Working in Elevated Positions.

When working in an elevated position, especially above live or moving parts, assure yourself of the security of your position and support, and take precautions to avoid dropping tools or materials.

G. Handling Switchboard Equipment.

All ungrounded metal parts of devices on switchboards shall be handled as if operating at the highest voltage to which any portion of the equipment on

430. G. Handling Switchboard Equipment—Continued.

the same switchboard panel is subject, unless the parts are known, by test or otherwise, to be free from such voltage.

When cable plug connectors are used, do not allow one end to remain hanging loose while the other end is connected to a live terminal.

In handling instrument circuits, never open the secondary of a current transformer while it is alive.

H. Reporting Circuit Trouble to Chief Operator.

Report to your immediate superior or to the chief operator any unusual conditions of load and the indication of any accidental ground on an outgoing circuit.

I. Reporting Defects.

Promptly report to your superior any dangerous conditions of equipment or surroundings, including defective tools, switches, or protective devices, or live cases or frames of apparatus or instruments.

431. METERS.

A. Application of Rule.

All meter setters and testers shall study and strictly observe the following in addition to all the general rules in 420 to 424 which apply to their work.

B. Taped Joints.

Never leave joints or loose ends of wires untaped unless otherwise protected

C. Care About Live Parts.

Do not use bare fingers or hands to determine whether a circuit is alive. Never remove or replace fuses in live circuits of more than 750 volts except by means of the suitable appliances provided.

D. Opening Circuits at Switches.

Special care should be exercised in opening circuits at meter connections unless the circuits have been first properly opened at switches.

431. Meters—Continued.

E. Current-Transformer Secondaries.

Before working on an instrument or other device in a current-transformer secondary circuit, always bridge the device with jumpers, so that the circuit can not be opened at the device. Never open such a circuit at meter connections until it has been bridged elsewhere.

F. Special Tools.

Use only hand tools suited to the work being done and so reduce the danger of short-circuits.

G. Reporting Defects.

Promptly report to your immediate superior any live meter case or any condition of a meter or its connections, of the interior wiring or of overhead lines, of your own or other utilities, which might endanger life and property.

432. TESTING.

A. Application of Rule.

All electrical testers, helpers, and others working about electrical tests shall study and strictly observe the following, in addition to all the general rules in 420 to 424. Owing to the diversified character of testing work, this study should usually extend also to the special rules in 433 to 435.

B. Authorization for Work

Do not work on or about equipment or lines without first receiving authorization from the person in charge.

Note: If such equipment or lines are under control of a chief operator, this authorization must come from him. This will include the attaching of tags at the proper points and the observation of all rules for general operation in 421.

C. Checking of Conditions.

Thoroughly familiarize yourself with all conditions

432. C. Checking of Conditions—Continued.

surrounding equipment or lines to be tested before making any change in these conditions.

Do not make any change in equipment or lines unless you fully understand the effect of the change. Be very careful of capacity effects of transformers and other high-voltage apparatus, the discharge from which may be very dangerous if passed through the body. Ground the coils before touching them.

D. Foreman.

One properly qualified person shall be in immediate charge of all testing work, or all of the workmen shall be instructed as to the work they are to perform and the employee instructing them shall be considered in charge of the work.

E. Warnings and Barriers.

Display danger signs and erect suitable guards about all equipment or lines under test if in places where traffic is frequent, if live or moving parts would otherwise be exposed.

When temporary wiring, belts, pulleys, or other temporary live or moving parts must be guarded, suitable portable or temporary guards and warning signs shall be used.

F. Requirement for Two Workmen.

No person should work alone in testing or experimental work on or about parts on which the voltage can exceed 750 volts between conductors, except in routine testing where the live parts are properly guarded.

G. Reporting Defects.

Promptly report to your immediate superior any conditions of equipment or lines under test which may endanger life or property.

433. OVERHEAD LINES.

A. Application of Rule.

Linemen and assistants and groundmen, in construc-

433. A. Application of Rule—Continued.

tion, extension, removal, or repair work, shall study and strictly observe the following, as well as all the general rules in 420 to 424 which apply to their work.

B. Testing Structures Before Climbing.

Before climbing poles, ladders, scaffolds, or other elevated structures, first assure yourself that the pole, ladder, scaffold, tree, cross arm, messenger wire, cable car, or boatswain's chair, or other elevated support, is strong enough to safely sustain your weight.

Note: Poles may be tested for decay near the ground line with a bar, screw driver, or other tool, and sounded for decay at the center by rapping with a heavy tool or block of wood.

If poles or cross arms are apparently unsafe because of decay or unbalanced tensions of wires on them, they should be properly braced or guyed before they are climbed.

C. Use of Pole Steps.

If poles are stepped, make use of such steps in climbing.

D. Unsafe Supports.

Do not support yourself by pins, brackets, or conductors.

E. Spurs.

Spurs with gaffs worn short shall not be used. The gaffs on spurs shall be kept sharp, and spurs shall fit properly. Spurs shall not be worn on work for which they are not required, nor while men are traveling to or from work.

F. Care About Live Parts.

1. Do not go among any wires until you know their voltage.
2. Leaning over and crowding through unprotected wires should be avoided wherever possible.
3. Place yourself so that you will not be liable to fall on wires should an accident occur.

433. F. Care About Live Parts—Continued.

4. Do not depend on the insulating covering of wires, and treat all lines as alive unless they have been properly killed (except communication lines known to be clear).
5. Avoid use of hand lines or measuring tapes containing metal strands.
6. In handling dangerous switches or fuses, do so only by means of suitable insulating handles, rods, or tongs.

G. When Touching Live Parts.

When working on live equipment or wires never allow any portion of the body to come in contact with any live or grounded part other than that worked on.

While touching supply wires or equipment, avoid as far as possible touching ground wires, guy wires, span wires, metal pipes, metal poles, metal sheaths, communication wires or equipment, transformer cases, hangers, and other metal fixtures.

Note: Communication wires are included principally because of their liability of being grounded. The other equipment and wires listed may become either alive or grounded.

While touching communication wires or equipment, metal sheaths, metal pipes, ground wires, or metal fixtures on poles, avoid as far as possible touching supply wires or equipment, guy or span wires.

H. Protecting Traffic.

When working overhead, keep tools and materials not in use in proper receptacles; tools or materials should not be thrown to or from the man on the pole, but should be raised or lowered by means of a hand line, using proper receptacles where practicable.

Pole holes and obstructions along public highways and other frequented places shall be protected by watchmen or by suitable guards or danger signals so located as to be conspicuous to traffic.

When working overhead, or hoisting or lowering

433. H. Protecting Traffic—Continued.

materials above places where frequent traffic occurs, a man should be stationed to warn passers-by.

Note: Where traffic is light, warning signs or barriers may be used in lieu of watchmen. Where traffic is congested, it may be necessary to rope off the space.

I. Avoid Falling Objects.

Do not unnecessarily stand where you can be struck by materials dropped by men working overhead.

J. Stringing Wires.

Never string wire near live lines except by means of suitable insulating hand lines or other appliances. Avoid bringing them in contact with the live wires. Regard them as live wires of the same voltage because of their liability to come in contact with the live wires.

Never change the strains on a pole by adding or removing wires until assured that the pole will stand the altered strains.

In stringing wires do not allow them to sag so as to endanger vehicles or pedestrians below, unless traffic is intercepted by watchmen or otherwise.

K. Reporting Defects.

Report promptly to your immediate superior any observed dangerous conditions, of your own or other utilities, arising from defective insulators, pins, cross arms, abnormally sagging wires, etc.

434. SERIES STREET LAMPS.

A. Application of Rule.

All series-lamp trimmers, hangers, and inspectors shall study and strictly observe the following, in addition to the general rules in 420 to 424 and the special rules under the sections for overhead and underground operation, respectively, in 433 and 436 which apply to their work.

B. Precautions on Series Circuits.

Series lamps and devices in series circuits should

434. B. Precautions on Series Circuits—Continued.

always be treated as alive unless disconnected by absolute cut outs or protected by the grounding of the circuit.

C. Handling Series Lamps.

Trimmers, inspectors, or patrolmen shall wear suitable insulating gloves and stand on insulating stools, platforms, or tower wagons, or on dry, well seasoned wood poles while touching series lamps or their cut outs, when these are alive.

Where insulating stools, platforms or tower wagons are used which provide sufficient insulation from ground for the voltages to be handled, the insulating gloves may be dispensed with.

D. Bridging Series Lamps.

Before working on lamps or other devices in live series circuits always bridge the device with jumpers such as series lamp cut outs usually provide.

Note: This will insure that the circuit will not be opened at the device, and possibly be completed through your body, or will not arc at the point of opening and burn you.

E. Testing Series Lamp Circuits.

Series lamp circuits should not be tested at their full operating voltage unless it is impracticable to test otherwise. Tests should be made only in accordance with a time schedule, concerning which all persons whose safety may be affected are informed.

F. Periodically Disconnected Circuits.

If circuits, such as series lamp circuits, are not effectively grounded during the idle period, all rules for handling live parts shall be strictly observed.

G. Reporting Defects.

Report promptly to your immediate superior any abnormally sagging wires, broken insulators, leaning poles, defective pole steps, broken globes or lamp supports, and other defects giving rise to a dangerous

434. G. Reporting Defects—Continued.

condition of your own or other utilities, or any indication of voltage on lines supposed to be dead.

435. COMMUNICATION CIRCUITS USED IN CONNECTION WITH SUPPLY LINES.

A. Application of Rule.

All men working on or near telephone and telegraph circuits operated in connection with supply lines shall study and strictly observe the following in addition to all the general rules in section 42 and the special rules 433 and 436 which apply to their work. For rules governing the operation of commercial communication lines see sections 44 and 45.

B. Title of Official in Charge.

In those rules where the words "chief operator" are used the official in charge of safeguarding operation is to be understood.

C. Precautions Before Climbing Poles.

Make a careful inspection to ascertain if possible whether there are any crosses with supply circuits before climbing poles or other structures to work on or about communication wires, especially where such poles or structures are occupied in common with, or located near power circuits.

Apply mechanical tests as far as practicable to messenger wires before trusting the wires to carry your weight.,

D. Approaching Supply Wires.

Avoid contact with all wires other than those you know to be communication wires, always assuming such other wires to be alive.

Do not approach any supply wire or supply equipment within the distances given in rule 422, B and C, unless you can comply with all the rules under that section, as far as they apply.

Note: Communication wires in trouble may be in contact with supply wires at some distant point, and should be treated with proper care.

435. Communication Circuits Used in Connection with Supply Lines—Continued.

E. Touching Equipment.

While handling communication wires, metal sheaths, or communication equipment avoid touching guy or span wires and supply wires or equipment. Especially avoid standing on or touching transformer cases, hangers, or connections.

While touching open communication wires avoid contact also with grounded parts, such as sheaths and ground wires.

F. Stringing Wires.

When stringing wires or cables over or under supply circuits avoid any possibility of their coming in contact. Do not string them above live supply circuits where it is practicable to avoid it.

Where liability of contact can not be entirely avoided, the wires being handled shall be treated as alive (unless they are effectively grounded), and the rules of 422, so far as they are applicable, shall be carefully observed.

G. Reporting Dangerous Conditions.

Promptly report to the proper official abnormally sagging wires, broken or defective insulators, pins, cross arms, defective poles, or any other dangerous conditions of your own or other utilities.

436. UNDERGROUND LINES.

A. Application of Rule.

All cable splicers and other workmen in underground construction or operation shall study and strictly observe the following, in addition to the general rules in 420 to 424, which apply to their work.

B. Guarding Manholes, Handholes, and Street Openings.

When removing manhole or handhole covers or making excavations, promptly protect the opening with

436. B. Guarding Manholes and Street Openings—Contd.

a barrier, temporary cover, or other suitable guard, and see that danger signals or red lights are displayed in a location conspicuous to the traffic until permanent covers are in place or the excavations are filled.

Exception: Red lights are not required on private right-of-way or at other locations not accessible to vehicular or pedestrian traffic.

C. Testing for Gas.

Do not enter manholes until you have assured yourself that the manholes are free from dangerous gases, by testing with approved safety lamps, by ventilation, or by other adequate methods. (See rule 452, B, for testing for gas.)

D. Watchman on Surface at Manholes.

Do not enter a manhole unless a temporary cover is placed over the opening or a watchman is stationed at the surface. Where any gas is liable to be present always see that the watchman is stationed at the surface. Where any hazard is involved do not leave a manhole unwatched until all workmen are out.

E. Avoiding Flames.

Do not smoke in manholes and avoid as far as practicable open flames or torches in or near manholes. Avoid sparks in handling live parts or cable sheaths, and avoid igniting the flux in soldering and wiping joints. In using hot paraffin see that it does not reach a temperature at which it will ignite. (See rule 452, D, for avoiding flames.)

F. Pulling Cables.

When pulling in cables make sure that the gear can not slip so as to injure workmen. Avoid the danger of having the hands drawn into the tackle by the pulling line.

G. Unidentified Cables.

If lines and cables are not properly identified by markings or positions, do not work upon them.

436. Underground Lines—Continued.

H. Testing and Splicing Live Cables.

Always ascertain, if practicable, whether cables are alive, by testing with the test devices provided, before cutting into the cable sheaths. Live cable should be spliced only by men experienced in the work, and they should use extreme caution and suitable devices in so doing.

I. Reporting Defects.

Promptly report to your immediate superior any dangerous condition of your own or other utilities, whether observed in underground or overhead construction. Particularly report insanitary conditions, gas, or missing cable tags in manholes, and abnormally sagging wires or broken supports in overhead construction.

437. TUNNEL AND SUBWAY.

A. Application of Rule.

Tunnel and subway electricians, operators, and others working on or about underground electric equipment (not in stations, substations, or in underground conduit systems) shall study and strictly observe the following, in addition to the rules in 420, 421, 422, 430, and 436, so far as they apply to their work.

B. Dangerous Locations.

The value of insulation (insulating covering) as protection from shock is reduced by the dampness usually present in these and similar locations. The restricted spaces often bring the worker closer to equipment and wires than in other kinds of electrical work, and the imperfect illumination also makes special care necessary to avoid contacts. The human body and all surrounding surfaces become more conducting where dampness exists, and electrical shocks are, therefore, more severe.

C. Live Electric Parts.

Before handling any electric equipment or wires make sure whether they are alive or dead.

437. C. Live Electric Parts—Continued.

Note: It is not advisable to work on live equipment or wires if the current can be shut off without interrupting necessary operations.

D. Unauthorized Work.

Never touch or disturb any electric equipment or wires without being authorized.

E. Standing on Ground.

1. Do not touch any electric wire, cable, or third rail, no matter how well it is insulated, while you are standing on the ground or on a grounded conducting surface, such as a pipe, track, or rail.
2. Do not touch the metal frame or case of a motor if it is ungrounded, and you are in contact with ground or a grounded object.

   Note: Remember that water and the surfaces of damp ground are conducting. Insulation on a wire may look perfect, but it frequently will not prevent shock.

F. Carrying Tools.

In carrying tools or metal implements in passageways containing electric wires, especially near exposed wires, never permit the tools or implements to touch them.

In particular, do not carry such objects on the shoulder when there are conductors overhead. Do not travel on that side of passageways where third rails or side trolley wires are exposed.

G. Handling and Repairing Live Parts.

1. When necessary to handle or repair live trolley wires, third rails, cables, motors, or other electric equipment, wear suitable insulating gloves or stand on the waterproof insulating mats or platforms provided, or obtain dry wood free from metal.

   Do not rely entirely on gloves for protection. The gloves may have been punctured since they were previously tested.

437. G. Handling and Repairing Live Parts—Continued.

2. Before handling or making use of any electric cable, carefully examine it to make sure that its insulation is not injured.

H. Inspection of Portable Cables.

Portable cables should be inspected at least once daily during the period of their use.

I. Handling Portable Devices.

In handling portable motors or lamps, first make sure that the external metal frame is not alive by contact with or leakage from live parts within.

Have such portable equipment inspected at least once daily during the period of their use.

J. Fuses and Switches.

Never handle fuses nor close switches or circuit-breakers unless you are authorized to perform that special duty, and then use the insulating handles or rods provided.

Before closing switches first make sure that you are not endangering other persons.

K. Injuring Cables and Wires.

Do not fire shots (blasting), handle tools, or perform other work in such manner as to injure cables or wires in the vicinity. If in doubt, consult your superior.

L. Temporary Wiring.

Never use bare conductors, nor arrange for earth return, in the wiring of any temporary circuit.

Note: This particularly applies to the temporary portions of shot-firing circuits and to the leads of portable motors and lamps.

Never employ temporary circuits without seeing that there are installed at the junction with the permanent wiring, suitable disconnecting switches or plug con-

437. L. Temporary Wiring—Continued.

nectors, arranged to disconnect all conductors of the temporary circuit by a single operation.

For shot-firing circuits, their disconnectors should be left open until the shot is to be fired, and should preferably be arranged for locking in the open position.

M. General Precautions.

Never get on or off locomotives or cars on the side where the trolley wire or third rail is located.

Do not place combustible or explosive materials near electric wires, trolley tracks, third rails, or motors.

Do nothing that will cause sparking, or expose parts that may arc or spark during operation, if any explosive gases may be present.

N. Reporting Dangerous Conditions.

Promptly report to your superior any dangerous or unusual conditions observed. In particular, report the presence of gas, broken insulators, bad insulation on wires, defective third-rail construction, live frames of motors, broken ground wires on motor frames, and sparking, arcing, or shocks noticed at any point. Report also any fallen, crossed, or abnormally sagging wires, whether electric wires or not. This includes trolley wires at switches and crossings and wires injured through falling roofs.

SEC. 44. COMMUNICATION SYSTEMS—RULES FOR EMPLOYERS

440. DISTRIBUTION AND ENFORCEMENT OF RULES.

A. Distribution.

The employer shall furnish to each regular employee working on or about commercial telephone or telegraph equipment or lines, safety rules governing his conduct while so engaged, and shall take suitable means to secure the employee's compliance with the same.

440. Distribution and Enforcement of Rules—Continued.

B. Form.

The safety rules furnished to any employee may be in such form as the employer may determine is best suited to the needs of individual employees. They shall, however, include the principles set forth in the following rules, or at least such part thereof as is applicable to the work in which the employee is engaged, and shall not conflict with these rules.

C. Interpretation.

If a difference of opinion arises with regard to the meaning or application of these rules, or as to the means necessary to carry them out, the decision of the employer or his authorized agent shall be final, subject to an appeal (if taken) to the regulatory body having jurisdiction.

441. ADDRESS LIST AND EMERGENCY RULES.

The rule books should contain or be accompanied by the following:

A. A list of names and addresses of those physicians and members of the organization who are to be called upon in emergencies.

B. A copy of rules for first aid, prone-pressure method of resuscitation, and fire extinguishment.

These should also be kept in conspicuous locations in central offices, on line wagons, and in other locations where the number of employees and nature of the work warrant.

442. INSTRUCTING EMPLOYEES.

Employees regularly working on or about communication equipment or lines, if their duties render such training necessary, shall be thoroughly instructed in approved methods of first aid, the prone-pressure method of resuscitation, and fire extinguishment, and if advisable, regularly drilled.

Groups of employees, such as commercial telephone operators, shall be thoroughly drilled to make prompt and orderly exit from buildings in case of fire.

443. QUALIFICATION OF EMPLOYEES.

The employer shall use every reasonable means and precaution to assure himself that each employee is mentally and physically qualified to perform his work in accordance with these rules.

444. PROTECTIVE DEVICES.

There shall be provided in conspicuous and suitable places in stations and on line wagons a sufficient supply of suitable protective, first-aid, and fire-extinguishing equipment to enable employees to meet the requirements of these rules. Such devices and equipment shall be inspected or tested to insure that they are kept in good order and in dependable condition, and shall not be used unless so inspected or tested. The following is a list of suitable devices and equipment, the kinds and numbers of which will depend on the requirements of each case:

A. First-aid outfits.
B. Insulating wearing apparel, such as insulating gloves, boots, and shields.
C. Safety belts.
D. Fire-extinguishing apparatus.

SEC. 45. COMMUNICATION SYSTEMS—RULES FOR EMPLOYEES

450. GENERAL PRECAUTIONS.

A. Heeding Warnings, Warning Others.

Employees should cultivate the habit of being cautious, heed warning signs and signals, and always warn others when seen in danger near equipment and lines.

B. Inexperienced Employees.

No employee shall do work for which he is not properly qualified on or about equipment or lines, except under the direct supervision of an experienced and properly qualified person.

450. General Precautions—Continued.

C. Electric Supply Equipment or Wires.

Workmen whose duties do not require them to approach or handle electric supply equipment and wires should keep away from such equipment or wires.

Electric supply equipment and wires should always be considered as alive unless positively known to be dead.

D. Safe Supports and Safety Belts.

1. SAFE SUPPORTS.

Employees should not support themselves on any portion of a tree, pole structure, lamp bracket, or similar fixtures on poles, scaffold, ladder, roof, skylight, or other elevated structure without first making sure that the supports are strong enough, reinforcing them if necessary.

Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the supporting surfaces are smooth or vibrating.

Insecure makeshift substitutes for ladders should not be used. An employee should never trust his weight on thin wooden boxes, sinks, washbowls, window shelves, or chair backs.

A ladder should not be placed upon a box, barrel, or other movable or insecure object.

Care should be taken to see that chairs, rolling ladders, and similar equipment are in first-class condition before being used.

2. SAFETY BELTS.

Employees should not work in elevated positions unless secured from falling by a suitable safety belt or other adequate means (sometimes including suitably located pole steps). Before an employee trusts his weight to the belt, he should determine that the snaps or fastenings are properly engaged and that he is secured in his belt.

450. D. Safe Supports and Safety Belts—Continued.

3. SAFETY ROPES.

Ropes used for supporting boatswains' chairs, platforms, or for other purposes on which the security of the employee depends shall be frequently inspected to assure that they are maintained in good condition.

E. Duties of Foreman.

1. DUTIES.

Each foreman in charge of work shall see that the safety rules are observed by the employees under his direction. He shall make all necessary records; reporting to his superior when required. He shall permit only authorized persons to approach places where work is being done. He shall adopt such precautions as are within his power to prevent accidents, and prohibit the use of tools or devices which are defective, or not suited to the work in hand.

2. QUALIFIED GUIDES.

The qualified person accompanying uninstructed workmen or visitors near electric equipment or lines shall take precautions to provide suitable safeguards and see that the safety rules are observed.

F. Handling Live Parts.

No employee should touch, with bare hands, any exposed ungrounded live part of more than 150 volts to ground, unless he is insulated from other conducting surfaces, including the ground itself. If employees must touch, at the same time, two parts between which a considerable potential exists, insulating gloves or other protection shall be used.

G. Power Circuits in Central Offices.

When making repairs on electric light or power circuits, the circuits shall, whenever possible, be made dead.

Where practicable, moving apparatus, as, for

450. G. Power Circuits in Central Offices—Continued.

example, a fan, shall be stopped before working upon it.

None other than duly authorized persons shall be admitted to central-office transformer vaults or battery rooms.

Care shall be used while working on or near circuits of more than 150 volts to ground, particularly in alternating-current districts.

H. Handling Fuses or Brushes.

When working on the brushes of a machine in operation, employees shall use care not to break a circuit, the flashing of which may injure the eyes or burn the hands. If it is necessary to remove a brush from the holder, the machine shall be shut down.

When inspecting or changing fuses, care should be taken to prevent injury to the eyes. If it is necessary to handle the fuses, the circuit should be cut off, if possible.

I. Battery Rooms.

Smoking, or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided as they may ignite the gas if discharged close to its source, as at the vent of a sealed-type cell during overcharging.

The electrolyte of storage batteries, and spray containing electrolyte, are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothes should be avoided.

Do not handle live parts of batteries or their connections unless adequate precautions are taken to avoid shock.

451. OVERHEAD LINES.

A. Precautions to be Observed Before Climbing Structures.

Before climbing poles, ladders, scaffolds, or other elevated structures first assure yourself that the

451. A. Precautions to be Observed Before Climbing Structures—Continued.

pole, ladder, scaffold, tree, cross arm, messenger wire, cable car, boatswain's chair, or other elevated support is strong enough to safely sustain your weight.

On pole-replacement work no pole shall be climbed for the purpose of clearing it of all wires and cables without first guying or bracing the pole securely.

If poles or cross arms are apparently unsafe because of decay, or unequal pulls of wire on them, they should be properly braced or guyed, if necessary, before they are climbed.

An uncoiled hand line, rope, or wire of any sort should not be fastened to the employee while climbing a pole, but where this must be done the employee should exercise due care to prevent the line from catching on obstructions.

In climbing poles careful watch should be kept for nails or other foreign attachments which might catch in the clothing and cause a fall.

B. Use of Pole Steps.

When poles are stepped make use of such steps in climbing, first making sure that the steps are firmly set in solid material before trusting your weight upon them. Pay particular attention, on icy poles, to each step.

Do not support yourself by pins, brackets, or conductors.

C. Spurs.

Spurs with gaffs worn short shall not be used. The gaffs on spurs shall be kept sharp and spurs shall fit properly. Spurs shall not be worn on work for which they are not required, nor while men are traveling to or from work.

D. Approaching Supply Lines.

Avoid contact with all wires other than those you know to be communication wires, assuming such other wires always to be alive. Communication wires in trouble may be in contact with supply con-

451. D. Approaching Supply Lines—Continued.

ductors at some distant point, and should be treated as live supply wires unless known to be free from any dangerous voltage.

Do not approach any supply wire or supply equipment within the distances given in rule 422 under section 42, unless you comply with all the rules under that section.

E. Touching Equipment.

While handling communication wires, metal sheaths, or communication equipment avoid touching trolley or arc-lamp span wires and supply lines or equipment. Especially avoid standing on or touching transformer cases, hangers, or connections.

F. Care About Electric Supply Lines.

Do not go among any wires until you know their voltage.

Leaning over and crowding through unprotected supply wires should be avoided wherever possible.

Place yourself so that you will not be liable to fall on supply wires should an accident occur.

Do not depend on the insulating covering of wires, and treat all wires as alive unless they have been killed properly (except communication wires known to be clear).

Treat also as alive all wires (unless thoroughly grounded) which are being strung near supply wires; regard them as being of the same voltage as the supply wires.

Avoid use of hand lines or measuring tapes containing metal strands.

When necessary to work in the vicinity of supply wires, transformers, and similar equipment assure yourself before starting work that the position of the body is such that should you momentarily forget yourself or fall, no portion of the body will come in contact with the foreign wires or equipment. Have

451. F. Care About Electric Supply Lines—Continued.

the supply circuits killed where possible before approaching them.

Railway span wires, pull-offs, and trolley brackets shall be treated as if alive, even though equipped with strain or other insulators.

G. Stringing Wires.

Never string wires near live circuits except by means of suitable insulating hand lines or other appliances.

Avoid the use of single or paired wires as a substitute for a hand line.

Wires should not be strung above live circuits operating at more than 750 volts, unless the wires being strung are effectively grounded or otherwise suitably protected, or in handling them all the precautions are observed as provided in rule 422, for work on parts at the voltage of the circuits concerned, and the spacings maintained.

Never change the strains on a pole by adding or removing wires until assured that the pole will stand the altered strains.

When wires are being pulled up on corner poles employees should stand in such a position that they can not be struck by the wire in case it slips.

Where it is necessary to remove communication wires below which are supply wires, power should be shut off of the supply wires where possible, and, if this is not practicable, rope cradles and suitable guards should be erected. Extraordinary care should be exercised to prevent the communication wires from sagging into the supply wires.

In stringing wires, cables, messengers, span wires, or guys do not allow them to sag so as to endanger vehicles or pedestrians below, unless traffic is intercepted by watchmen or otherwise. This may necessitate keeping a watchman at the coil or reel.

When stringing wires for long distances, precautions shall be taken to prevent the possibility of vehicles

451. G. Stringing Wires—Continued.

or pedestrians coming into contact with the wires at the intersecting streets or highway crossings.

H. Protecting Traffic.

When working overhead, keep tools and materials not in use in proper receptacles; tools or materials should not be thrown to or from the man on the pole, but should be raised or lowered by means of a handline, using a proper receptacle, if practicable. Also tools and loose materials should not be left at the top of poles, ladders, or other elevated structures. Workmen shall not stand where they are liable to be struck by materials dropped by men working overhead.

Pole holes, open manholes, excavations, and obstructions along the public highway and other frequented places shall be protected by watchmen, barriers or suitable guards, warning signs, or danger signals so located as to be conspicuous to traffic.

When working overhead or hoisting or lowering materials above places where traffic occurs, a man should be stationed to warn passers-by.

Where traffic is light, warning signs may be used in lieu of watchmen. Where traffic is congested, it may be necessary to rope off the space.

I. Reporting Dangerous Conditions.

An employee should report as soon as practicable to his superior or some suitable authority any obvious hazards to life or property observed in connection with any electric equipment or lines.

Any imminently dangerous conditions shall be guarded until they can be made safe.

452. UNDERGROUND LINES.

A. Guarding Manholes, Handholes, and Street Openings.

When removing manhole or handhole covers or making excavations, promptly protect the opening with a barrier, temporary cover, or other suitable

452. A. Guarding Manholes, Handholes, and Street Openings—Continued.

guard, and see that danger signals or red lights are displayed in a location conspicuous to the traffic until permanent covers are in place or the excavations are filled.

Exception: Red lights are not required on private right-of-way or at other locations not accessible to vehicular or pedestrian traffic.

B. Testing for Gas.

Do not enter manholes until you have assured yourself that the manholes are free from dangerous gases, as indicated by approved safety lamps, by ventilation, or by other adequate methods.

When work is being carried on for any length of time in manholes where gas collects, suitable ventilation shall be provided, or tests with the safety device should be repeated at regular intervals to make certain that gas is not accumulating in the manhole in dangerous quantities.

C. Watchman on Surface at Manhole.

Where any hazard to the workmen is involved observe the following:

1. Do not enter a manhole unless a man is stationed at the surface.
2. Do not leave a manhole unwatched until all workmen are out.

D. Avoiding Flames.

Do not smoke in manholes, and avoid as far as practicable open flames or torches in or near manholes.

If it is necessary to illuminate a manhole, electric lights only should be used. When doing this, it should be known that the leads, sockets, and connections are well insulated and in good condition in order to avoid the possibility of a spark. Special attention should be paid to the sparking of any motors used for ventilating purposes.

452. D. Avoiding Flames—Continued.

Avoid sparks in handling live parts or cable sheaths, and avoid igniting the flux in soldering and wiping joints. In using hot paraffin see that it does not reach a temperature at which it will ignite.

In central-office cable vaults, tests shall be made for the presence of gas before using exposed flames, and such flames shall not be used in vaults where gas collects.

E. Pulling Cables.

When pulling cables, make sure that the gear can not slip so as to injure workmen. Avoid the danger of having the hands drawn into the tackle by the pulling line.

F. Reporting Dangerous Conditions.

Promptly report to your immediate superior any dangerous condition of your own or other utilities, whether observed in underground or overhead construction. Particularly, report unsanitary conditions, gas, or missing cable tags in manholes and abnormally sagging wires or broken supports in overhead construction.

PART 5. RULES FOR RADIO INSTALLATIONS

CONTENTS

Page
Sec. 50 Scope 361
500. Scope 361
Sec. 51. Classification of radio stations 361
510. Classification of radio stations 361
Sec. 52. Antenna and counterpoise installation 362
520. Application of rules 362
521. General requirements 362
522. Locations to be avoided 363
523. Ordinary construction of antenna systems 364
524. Special construction of antenna systems 368
525. Guarding of antennas 370
526. Supply circuits as antennas or grounds 370
Sec. 53. Lead-in conductors 370
530. Application of rules 370
531. Material 370
532. Size 371
533. Installation of lead-in conductor 371
Sec. 54. Construction at building entrance 373
540. Application of rules 373
541. Entrance 373
542. Creepage and air-gap distance 373
543. Mechanical protection of bushings 374
Sec. 55. Protective devices 374
550. Application of rules 374
551. Receiving stations 374
552. Low-power transmitting stations 374
Sec. 56. Protective and operating grounding conductors 375
560. Application of rules 375
561. General 375
562. Material and size 375
563. Installation of grounding conductors 376
Sec. 57. Grounds and ground connections 376
570. Application of rules 376
571. Grounds 377
572. Attachment to pipes 377
573. Attachment to driven pipes, rods, or buried plates 378
Sec. 58. Connection to power supply lines 378
580. Application of rules 378
581. Receiving stations and low-power transmitting stations 378
Sec. 59. Batteries 379
590. Application of rules 379
591. Care in handling 379
592. Portable batteries 379

SEC. 50. SCOPE

500. Scope.

The rules of part 5 apply to radio-transmitting and receiving installations, including antennas, counterpoise wires, lead-in conductors, grounding conductors, grounding connections, protective devices, and batteries. The rules do not apply to mobile or portable installations of any type, nor to equipment and coupling wires used for coupling carrier-current equipment to supply-line conductors. In case the installation is covered by more than one rule, the superior requirement shall apply.

SEC. 51. CLASSIFICATION OF RADIO STATIONS

510. Classification of Radio Stations.

For the purpose of these rules, radio stations are classified as follows:

A. Receiving stations.

B. Transmitting stations.

The power rating of transmitters shall be the rating authorized by the Federal Communications Commission or other authorized Federal regulatory body in granting construction permits and licenses. For the purpose of this code, transmitting stations are divided into three groups as follows:

1. LOW POWER.

   Transmitting stations having a licensed operating power less than 100 watts and a maximum plate supply voltage (dc or rms ac) less than 750 volts.

2. MEDIUM POWER.

   Transmitting stations not classified as low power or high power.

510. B. Transmitting Stations—Continued.

3. HIGH POWER.

Transmitting stations having a licensed operating power greater than 1,000 watts or a maximum plate supply voltage (dc or rms ac) greater than 5,000 volts.

Note: In the case of amateur stations, the classification under these rules shall be determined by the voltage used on the plate of the last tube of the transmitter.

SEC. 52. ANTENNA AND COUNTERPOISE INSTALLATION

520. Application of Rules.

These rules apply as follows:

A. Outdoor Antennas of All Classes of Stations (as defined in 510, A and B).

There are no requirements for indoor antennas, except that they shall meet the requirements for clearance from the conductors of other systems specified in rule 533, C. In general, transmitting antennas should not be located indoors.

B. Counterpoise Wires.

C. Ground-System Wires.

There are no requirements for the ground-system wires of an antenna.

521. General Requirements.

A. Antennas.

1. ANTENNAS OF RECEIVING STATIONS.

Such antennas shall comply with the requirements for the construction of communication lines for public use in similar situations, as given in part 2 of this code.

2. ANTENNAS OF TRANSMITTING STATIONS.

Such antennas shall comply with the requirements for the construction of supply lines for public use in comparable situations and for the voltage concerned, as given in part 2 of this code.

521. General Requirements—Continued.

B. Counterpoise Wires.

Counterpoise construction shall conform to the requirements for that of the associated antenna as regards location and clearances with respect to conductors of other systems.

522. LOCATIONS TO BE AVOIDED.

A. Medium and High-Power Transmitting Stations.

The following situations shall be avoided in erecting the antenna, counterpoise, and guy-wire systems of medium and high-power transmitting stations:

1. Attachment of any wires of the systems to poles which carry the conductors of any electric supply or communication circuits.
2. Crossings (above or below) or conflicts of any of the wires of the systems with the conductors of any electric supply or communication circuits.
3. Crossing over streets, highways, or the tracks of any railroad.

B. Receiving and Low-Power Transmitting Stations.

1. In relation to circuits of more than 250 volts—The following situations shall be avoided in erecting the antenna, counterpoise, and guy-wire systems of receiving and low-power transmitting stations, except for the equipment of public utilities attached to their own poles:
    (a) Attachment of any wires of the systems to poles which carry electric supply or communication circuits of more than 250 volts to ground.
    (b) Crossings (above or below) or conflicts of any of the wires of the systems with the conductors of any electric supply or communication circuits of more than 250 volts to ground.

522. B. Receiving and Low-Power Transmitting Stations—Continued.

2. In relation to circuits of less than 250 volts—

The following situations should be avoided whenever possible in erecting the antenna, counterpoise, and guy-wire systems of receiving and low-power transmitting stations, except for the equipment of public utilities attached to their own poles:

(a) Attachment of any wires of the systems to poles carrying the conductors of electric supply or communication circuits, none of which exceeds 250 volts to ground.

(b) Crossings or conflicts of any wires of the systems with the conductors of any electric supply or communication circuits of less than 250 volts to ground.

(c) Crossing over streets, highways, or the tracks of any railroad.

523. ORDINARY CONSTRUCTION OF ANTENNA SYSTEMS.

If all of the situations listed in rule 522 are avoided, antenna systems should be constructed in accordance with rule 523. If any of the situations of rule 522, B, 2, are not avoided, antenna systems shall be constructed in accordance with rule 524.

A. Antenna Conductors.

1. MATERIAL.

Antenna conductors should be of copper, copper-covered steel, bronze, or other corrosion-resistant material of adequate strength.

2. SIZE.

Antenna conductor sizes should be not less than given in table 1.

523. A. Antenna Conductors—Continued.

TABLE 1.—*Antenna conductor sizes—ordinary construction*

Material	Receiving and low-power transmitting			Medium and high-power transmitting		
	Span length			Span length		
	Less than 35 feet	35 to 150 feet	Exceeding 150 feet	Less than 35 feet	35 to 150 feet	Exceeding 150 feet
	AWG No.	*AWG No.*	*AWG No.*	*AWG No.*	*AWG No.*	*AWG No.*
Copper:						
Soft-drawn	19	14	8	14	7	----------
Medium-drawn	19	14	10	14	8	----------
Hard-drawn	19	14	12	14	10	8
Bronze, copper-covered steel, or other high-strength, corrosion-resistant material	19	14	14	14	12	10

3. STRENGTH.

The conductor sizes listed in table 1 provide for minimum strength without loading. In localities subject to glaze, ice, sleet, or snowstorms, comprised in the heavy- and medium-loading districts, additional strength should be provided. (See rule 250.) In determining the loading, the effect of lead-in conductors and the loading thereon should be included.

B. Antenna Insulators.

1. MATERIAL.

Insulators should be of noncombustible material.

2. DIELECTRIC STRENGTH.

(*a*) *Receiving and Low-Power Transmitting Stations.* No requirements.

(*b*) *Medium and High-Power Transmitting Stations.* Insulators should meet the requirements of rule 274 for the voltage developed on the antenna at the points of insulator attachment.

523. B. Antenna Insulators—Continued.

3. MECHANICAL STRENGTH.

Insulators should have a breaking strength not less than that of the smallest conductor which would be permitted by table 1.

C. Antenna Supports.

1. STRENGTH OF SUPPORTS.

All supporting structures should be so constructed as to carry the vertical, longitudinal, and transverse loads. They should be so erected that they are not dependent in general on the antenna for stability. Guys or braces may be used to obtain the necessary strength to withstand the longitudinal and transverse loads. Where the stability of the support is solely dependent on the guys, these should be led out in at least three approximately equally spaced directions from the support. In determining the loads, the storm-loading map given with rule 250 should be employed; also the effect of the lead-in conductors and the load thereon should be included.

Exception: If ice-melting arrangements are regularly utilized, ice loading may be disregarded.

2. GUYS.

Guys should be of galvanized steel, copper-covered steel, bronze, or other corrosion-resistant material, and should be of adequate size, and in any case not less than No. 14 AWG. They should be firmly attached to adequate anchors or to structures which will furnish a substantial anchorage. Where guys may be exposed to mechanical damage they should be provided with guards. Guys associated with antennas of transmitting stations where accessible to unauthorized persons shall be grounded or contain insulators complying with rule 283.

523. C. Antenna Supports—Continued.

3. ROOF SUPPORTS.

Antenna supports erected on roofs should be of substantial construction and, where necessary, shall be arranged to distribute the load over the roof.

4. CHIMNEYS.

The attachment of antennas or antenna supports to chimneys shall be avoided where such attachment might overload the chimney.

5. GROUNDING METAL SUPPORTS ON ROOFS.

Metal supporting poles or masts extending more than 10 feet above the supporting building shall be permanently and effectively grounded in conformance with the requirements of section 56, except poles or masts which themselves are used as antennas.

6. TREES.

Where antennas or guys are attached to trees, the location and method of attachment shall be such that swaying of the tree in the wind will not cause undue stress in the antenna conductors.

D. Strength of Attachment of Antennas to Supports.

The means used for attaching the antenna to the support shall be such as to withstand a load that will break the conductor itself. The use of a strain hook which will release the wire before it breaks is permissible if the circumstances of a particular installation warrant it.

E. Minimum Clearance above Ground and Roofs.

1. SPANS 150 FEET OR LESS IN LENGTH.

Antenna conductors in approximately horizontal spans shall have clearances above ground and roofs not less than given in table 2. These clearances do not apply to vertical antennas, or vertical lead-ins.

523. E. Minimum Clearance above Ground and Roofs—Continued.

TABLE 2.—*Minimum antenna clearances above ground or roof*

Location	Receiving and low-power antennas	Medium and high-power antennas
	Feet	*Feet*
Above roofs	8	8
Along road in rural districts	15	28
Above streets and roadways	18	28
Above roadways to residence garages	10	12
Above spaces or ways normally accessible to pedestrians only	10	12

2. SPANS EXCEEDING 150 FEET IN LENGTH.

For such spans the above clearances shall be increased by 0.1 foot for each 10 feet in excess of 150 feet.

524. SPECIAL CONSTRUCTION OF ANTENNA SYSTEMS.

Where any of the situations (a), (b), and (c) of rule 522, B, 2, are not avoided, the construction shall meet such of the following rules as may apply.

A. Recommendation Against Locating Antennas in Situations Where Special Construction is Required.

It is strongly recommended that the installation of antennas in these special situations be avoided.

Note: If such locations are employed, it must be recognized that special hazards are introduced and that great care is necessary in the construction and maintenance of antennas to avoid contact with supply or communication conductors and to avoid the reduction of clearance over highways or railroad tracks.

B. Attachment to Poles Carrying Conductors of Electric Supply or Communication Circuits of Less than 250 Volts to Ground.

The attachment to such poles shall be made in such a manner and at such a location on the pole as not to interfere with the operation or maintenance of the electric supply or communication circuits,

524. B. Attachment to Poles Carrying Conductors of Electric Supply or Communication Circuits of Less than 250 Volts to Ground—Continued.

and to provide a clearance of at least 40 inches below the conductors and equipment of the electric supply or communication circuits. The antenna conductor, counterpoise, or guy wires preferably should be attached below the foreign circuit attachments.

Exception: These requirements do not apply in the case of outdoor installations of radio equipment and antennas where the electric supply or communication circuits terminate in the radio equipment.

C. Crossings Over or Conflicts With Electric Supply or Communication Circuits of Less than 250 Volts to Ground.

In such locations the antenna conductors, counterpoise, or guy wires shall be constructed in accordance with the provisions of rule 523, and, in addition, a clearance of 6 feet shall be maintained at the crossing or throughout the conflicting section.

D. Crossings Under Electric Supply or Communication Circuits of Less than 250 Volts to Ground.

In such locations the antenna conductors, counterpoise, or guy wires shall be constructed in accordance with the provisions of rule 523, and, in addition, they shall be so constructed as to insure the maintenance of at least 2 feet from a communication conductor and of 4 feet from an electric supply conductor.

Note: It should be noted that for relatively long spans on the electric supply or communication circuit, the increase in sag with ice and wind loading is considerably more than for short spans, and allowances should be made accordingly when determining the clearance under fair-weather conditions.

524. Special Construction of Antenna Systems—Continued.

E. Crossings Over Streets, Highways, or Railway Tracks.

In such locations the antenna conductors, counterpoise, or guy wires shall be constructed in accordance with the provisions of rule 523 and, in addition, shall meet the requirements of part 2 for the strength and sag of conductors, strength of supports, and clearance above the roadway applicable to communication lines in such locations. Where the requirements of rule 523 differ from those of part 2, the requirements of part 2 shall control.

525. GUARDING OF ANTENNAS.

Antennas for transmitting stations except those of the shunt-excited; grounded-base type shall be installed so as not to be readily accessible to unauthorized persons.

526. SUPPLY CIRCUITS AS ANTENNAS OR GROUNDS.

Electric supply circuits shall not be employed as receiving antennas or as operating grounds through a conductive connection. They may be so used if suitable capacitors having a dielectric strength sufficient to withstand seven times the normal supply-circuit voltage and a capacitance of not more than 0.1 microfarad are inserted between the apparatus and each wire of the supply circuit.

SEC. 53. LEAD-IN CONDUCTORS

530. APPLICATION OF RULES.

The requirements of this section apply to lead-in conductors (including radio-frequency transmission lines) of receiving stations and low-power transmitting stations. Lead-in conductors of medium and high-power transmitting stations shall meet such of the requirements of part 1, supply stations, as apply for the voltages concerned.

531. MATERIAL.

Lead-in conductors shall be of copper, bronze, copper-covered steel, or other corrosion-resistant material.

532. SIZE.

The size of the lead-in conductor should not be less than that specified in table 1, the span length being taken as the distance from the point of attachment to the antenna to the first building attachment. Where the lead-in conductors are attached to intermediate supports, the maximum span shall be considered.

533. INSTALLATION OF LEAD-IN CONDUCTOR.

A. From Antenna to First Building Attachment.

This section of the lead-in wire shall conform to the requirements as specified in rules 523 and 524 for antennas similarly located.

B. From First Building Attachment to Building Entrance.

This section of the lead-in conductor shall be installed and maintained so that it cannot swing closer to the open conductors of communication, supply, or lightning-rod systems than the following distances:

Communication or supply circuits of 0 to 750 volts	2 feet.
Supply circuits exceeding 750 volts	10 feet.
Lightning-rod systems	6 feet.

Exception: The 2-foot clearance from communication or supply circuits of less than 750 volts may be reduced to not less than 4 inches if the lead-in conductor is separated from other conductors by a continuous and firmly fixed nonconductor which will maintain permanent separation. This nonconductor shall be in addition to any insulating covering on the wires.

Lead-in conductors of low-power transmitting stations shall be firmly mounted on insulating supports so as to clear by at least 3 inches the surface of the building. If the lead-in has an effectively grounded metal sheath, it may be attached directly to the surface and treated as a grounding conductor with respect to clearance and other requirements.

533. Installation of Lead-in Conductor—Continued.

C. From Building Entrance to Set.

1. RECEIVING STATIONS.

(a) Lead-in conductors shall be securely fastened in a workmanlike manner.

(b) Clearance between lead-in conductor and any supply conductor not in conduit shall not be less than 4 inches.

Exception 1: This 4-inch clearance does not apply if a firmly fixed nonconductor such as a porcelain tube affords a permanent separation. This nonconductor shall be in addition to any insulating covering on the wires.

Exception 2: This 4-inch clearance does not apply where the lead-in terminates in an outlet box which is also occupied by the conductors of another system, provided such outlet box is equipped with a barrier of sheet steel not less than No. 16 U. S. Standard Gage or a barrier of fire-resistant insulating material rigidly fastened to the box or its cover, or other device which assures positive separation between the lead-in conductors and the conductors of the other system.

2. LOW-POWER TRANSMITTING STATIONS.

(a) Lead-in conductors shall be securely fastened to suitable insulators which provide a clearance of at least 2 inches to the nearest surface.

(b) Clearance between lead-in conductor and any supply wire shall be at least 4 inches.

(c) Lead-in conductors shall be installed and protected to prevent persons from readily coming into accidental contact with them.

533. C. 2. Low-Power Transmitting Stations—Continued.

Exception: If the lead-in has an effectively grounded metal sheath, it may be treated as a grounding conductor and attached directly to any surface.

SEC. 54. CONSTRUCTION AT BUILDING ENTRANCE

540. Application of Rules.

The requirements of this section apply to construction at receiving stations and low-power transmitting stations. Construction at building entrance of medium- and high-power transmitting stations shall meet such of the requirements of part 1, supply stations, as may apply for the voltage concerned.

541. Entrance.

A. Receiving Stations.

Lead-in conductors for receiving stations shall be either insulated or surrounded by a grounded metallic sheath where they enter the building.

B. Low-Power Transmitting Stations.

Lead-in conductors for low-power transmitting stations, where not installed with a grounded metallic sheath, shall enter the building by one of the following methods: (1) through a rigid, noncombustible, nonabsorptive insulating tube or bushing; (2) through a drilled window pane; and (3) through an opening provided for the purpose in which the entrance conductors are firmly secured so as to provide a clearance of at least 2 inches. If the lead-in conductor is inclosed in an effectively grounded metal sheath, no further insulation is necessary.

542. Creepage and Air-Gap Distance.

The entrance bushing or window pane mentioned in rule 541 shall, in the case of low-power transmitting stations, afford a creepage and air-gap distance from extraneous bodies of not less than 2 inches. There is no requirement under this title for receiving stations.

543. Mechanical Protection of Bushings.

Entrance bushings of porcelain or other fragile material at low-power transmitting stations shall be protected where exposed to mechanical injury.

SEC. 55. PROTECTIVE DEVICES

550. Application of Rules.

The requirements of this section apply to protective devices for receiving stations and low-power transmitting stations. Protective devices for medium and high-power stations shall meet such of the requirements of part 1, supply stations, as may apply for the voltages concerned.

551. Receiving Stations.

A. Lightning Arrester.

Each lead-in conductor of a receiving station using an outdoor antenna shall be provided with a lightning arrester which will operate at a voltage of 750 volts or less.

Exception: If the lead-in conductor is protected by a continuous effectively grounded metal sheath, the lightning arrester may be omitted.

B. Location.

The lightning arrester may be located outside or inside the building as near as practicable to the point of entrance and convenient to a ground. The arrester shall not be placed in the immediate vicinity of easily ignitible material nor in a location exposed to dust, inflammable gases, or flyings of combustible materials.

552. Low-Power Transmitting Stations.

A. Protective Device.

Lead-in conductors of low-power transmitting stations shall be equipped with a grounding switch, lightning arrester, horn gap, or other suitable means for lightning protection. If no conducting path between the antenna and ground is provided in the

552. A. Protective Device—Continued.

connected equipment, means shall be provided to drain static charge from the antenna system.

Exception: Where the antenna itself is directly grounded, other forms of protection against lightning and static charge may be omitted.

B. Location.

The protective device may be located either outside or inside the building. The device should be placed in the most direct line between the lead-in conductor and the point where the grounding connection is made. The device shall not be placed in the immediate vicinity of easily ignitible material nor in a location exposed to dust, inflammable gases, or flyings of combustible material.

SEC. 56. PROTECTIVE AND OPERATING GROUNDING CONDUCTORS

560. Application of Rules.

The requirements of this section apply to grounding conductors of receiving stations and low-power transmitting stations. Grounding conductors of medium and high-power transmitting stations shall meet such requirements of section 9, grounding, and part 1, supply stations, as apply.

561. General.

The protective grounding conductor may be used also as the operating grounding conductor.

562. Material and Size.

A. Receiving Stations.

1. MATERIAL.

No requirements.

2. SIZE.

(a) *Operating grounding conductor.* No requirements.

(*b*) *Protective Grounding Conductor.* This conductor shall be not smaller than No. 14 AWG. copper and not smaller than the lead-in conductor.

562. Material and Size—Continued.

B. Low-Power Transmitting Stations.

The operating and protective grounding conductors of low-power transmitting stations shall be not smaller than No. 14 AWG. copper, and not smaller than the lead-in conductor.

563. INSTALLATION OF GROUNDING CONDUCTORS.

A. Method of Running.

1. Grounding conductors shall be run in as straight a line as practicable from the set or the protective device to a good effective ground as specified in section 57.
2. Grounding conductors may be run either inside or outside of the building.

   Recommendation: It is recommended that the protective grounding conductor for low-power transmitting stations be run outside of the building.

B. Mechanical Protection.

Grounding conductors shall be guarded against mechanical injury.

C. Insulation.

Grounding conductors may be of insulated or bare wire and need not be run on insulating supports.

D. Fuse Not To Be Used.

No fuse shall be included in the circuit between the lightning arrester and the protective ground.

SEC. 57. GROUNDS AND GROUND CONNECTIONS

570. APPLICATION OF RULES.

The requirements of this section apply to protective grounds and ground connections for receiving stations and to operating and protective grounds and ground connections of low-power transmitting stations. There are no requirements for operating grounds or ground connections for receiving stations. Grounds and ground

570. Application of Rules—Continued.

connections for medium and high-power transmitting stations shall meet such requirements of section 9, grounding, and part 1, supply stations, as apply.

571. GROUNDS.

A. Cold-Water Pipes.

Cold-water pipes shall preferably be used for grounds where such pipes are available and are connected or bonded to an extensive underground piping system or to a metallic well casing. An outlet pipe from a water tank fed by a street water main or a driven well may be used provided such outlet pipe is adequately bonded to the inlet pipe connected to the street water main or to the well casing.

B. Gas Pipes.

In the absence of cold-water pipes, an extensive underground gas piping system may be used provided the grounding-conductor connection is made between the gas meter and the street main.

C. Steam and Hot-Water Pipes.

Steam and hot-water pipes shall not be used for grounds.

D. Metallic Structures.

A metallic structure may be used as a ground, if effectively grounded.

E. Artificial Grounds.

In the absence of underground piping systems, driven pipes or rods or buried plates may be used. Steel or iron pipes or rods shall be galvanized or copper-coated.

572. ATTACHMENT TO PIPES.

Grounding conductors shall be attached to pipes by means of suitable ground clamps which will not fail because of corrosion or cause corrosion of the pipe, or by other means which will insure a good mechanical and electrical connection. The entire surface of the

572. Attachment to Pipes—Continued.

pipe to be covered by the clamp shall be thoroughly cleaned. Connections to such pipes shall not be made at the same point as used for grounding electric supply or communication circuits or equipment.

573. ATTACHMENT TO DRIVEN PIPES, RODS, OR BURIED PLATES.

The grounding conductor shall be attached to the rod, buried plate, or other body so as to give a reliable connection both mechanically and electrically. This connection shall be made so that it will not fail through corrosion even when the joint is buried in the earth. Driven pipes or rods or buried plates used as grounding electrodes shall not be used also as grounding electrodes for electric supply or communication circuits or equipment. This requirement, however, does not prohibit the bonding together of the grounds of these several services where such bonding seems desirable. Where an effective station ground has been established by bonding together a group of such driven pipes or rods or buried plates, connection may be made thereto even though this ground is also used for other services.

SEC. 58. CONNECTION TO POWER SUPPLY LINES

580. APPLICATION OF RULES.

The requirements of this section shall apply to connecting devices for receiving stations and low-power transmitting stations. Connecting devices for medium and high-power transmitting stations shall meet such requirements of part 1, supply stations, as may apply.

581. RECEIVING STATIONS AND LOW-POWER TRANSMITTING STATIONS.

Devices used in connection with power supply lines and methods of wiring employed at receiving stations and low-power transmitting stations shall be in accordance with the rules covering permanent or portable fixtures, devices, and appliances of part 3, sec. 37.

SEC. 59. BATTERIES

590. APPLICATION OF RULES.

The requirements of this section apply to batteries for receiving stations and transmitting stations of low and medium power. Large permanently installed batteries with a nominal voltage in excess of 50 volts, and batteries for high-power transmitting stations shall conform to section 13, part 1, rules for stations.

591. CARE IN HANDLING.

Care shall be used in handling batteries in order to avoid contacts with terminals having a high enough difference of potential to cause shock.

592. PORTABLE BATTERIES.

A. Ventilation.

Storage batteries shall be located where there is adequate ventilation.

B. Precautions.

Smoking, or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided, as they may ignite the gas if discharged close to its source, as at the vent of a sealed-type cell during overcharging. The electrolyte of storage batteries, and spray containing electrolyte, are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothes should be avoided.

Do not handle live parts of batteries or their connections unless adequate precautions are taken to avoid shock.

INDEX

	Rule	Page
Accessibility	323B	266
Disconnectors	323B	266
Lines	212	95
Overcurrent protection	320	261
Signs	363A	287
Switchboards	170	70
Switches	216A	97
Alarm boxes, fire and police	390B	301
Protective requirements	390B	301
Alternating-current circuits	93B2	19
Ground connections	94C2	23
Artificial grounds	94C2	23
Grounding	92B	16
Grounding conductor	93B2	19
Size and capacity	93B2	19
Anchor rods and guys	282G	218
Angles in line, strength requirements	261A	171, 179
Antenna lead-in bushings	543	374
Mechanical protection	543	374
Antenna systems	524	368
Special construction	524	368
Antennas	541	373
Guarding	525	370
Lead-in	541	373
Antennas, radio	520	362
Application of rules	520	362
Construction	523, 524	364, 368
General requirements	521	362
Locations	522	363
Strength of attachments	523D	367
Supports	523C	366
Apparatus:		
Identification in manholes	299	241
Location relative to climbing space	236D	132
Appliances, portable	371	289
Grounding metal parts	371	289
Hazardous locations	374C	292
Identified conductors	373	291
Insulation	370	289
Voltage limit	374A	291
Application	90	15
Grounding rules	90	15
Application of rules	201	93
Antennas	520	362
Communication circuits	435A	341
Intent	201A	93
Killing equipment and lines	423	327
Lead-in conductors	530	370
Meters	431A	334
Overhead lines	433A	336
Protective grounds	424A	330
Radio grounding conductors	560	375
Radio protective devices	550	374
Radio station grounds	570	376
Radio station	540	373
Batteries	590	379
Power supply	580	378
Series street lamps	434A	339

	Rule	Page
Application of rules—Continued		
Specialized work	430A	331
Supply equipment	101	33
Temporary installations	201C	94
Testing	432A	335
Tunnel and subway	437A	344
Underground lines	436A	342
Waivers	201D	94
Approved equipment	302A	248
Utilization equipment	302A	248
Arcing parts	184	75
Guarding	184, 329I	75, 275
Lightning arresters	184	75
Precautions	420F	315
Shielding	167	69
Arcing shields	121D	53
Arrangement	332	277
Fuses	324B	268
Panelboards	332	277
Switchboards	173, 332	71, 277
Switches	216, 324B	97, 268
Artificial electrodes	97B	28
Grounding conductors	97B	28
Artificial grounds	94C	23
Ground connections	94C	23
Number required	94C	23
Electrodes	95D	26
Attachment plugs	103D	36
Disconnection of poles	103D	36
Attendance	411A	311
Authorization for work	432B	335
Authorization, special	421D	318
Auxiliaries	122C	54
Grounding	122C	54
Avoiding flames	452D	357
Bare conductors (*see also* Uninsulated conductors)	311B	257
Barriers, testing	432E	336
Batteries, radio stations:		
Application of rules	590	379
Care in handling	591	379
Portable	592	379
Batteries, storage, general	130	56
Battery rooms	450I	352
Floors	135	58
Guarding live parts	137	58
Illumination	138	59
Supply stations	430E	333
Wiring	136	58
Bare parts (*see* Live parts).		
Belts, guarding	112	42
Blasting, tunnels	437K	346
Bonding	295	238
Brackets and racks	295	238
Grades B and C	261D	184
Grade D	262E	200
Bridges:		
Conductor clearances	234D	123
Conductor separation	235C	131
Brushes, handling	450H	352
Buckarms:		
Climbing space	236F	133
Working space	237D	136
Buildings:		
Clearances from	234C	120
Separation of conductors	235B	130
Bushing material	123B	54
Cabled services	263E4	207

	Rule	Page
Cables: (*see also* Cord and Conductors).		
Bonding	295	238
Communication:		
Covering	239G1	151
Strength	261I	191
Identification	298	240
Injuring in tunnels	437K	346
Insulation	375B	293
Live, in manholes	436H	344
Location in manholes	293	235
Portable, inspection	437H	346
Protection	297	239
Underground	294	237
Supply:		
Construction	241A	153
Covering	239F1	148
Strength	261G	190
Supports in manholes	292G	235
Trailing, construction	325B	293
Underground, construction	291	230
Unidentified	436G	343
Capacity:		
Disconnectors	164, 323B	67, 266
Switches	164	67
Capacity, switches, interrupting	323A	266
Care:		
Live parts	433F	337
Near live parts	420E	314
Supply lines	451F	354
Carrying tools in tunnels	437F	345
Checking conditions, testing	432C	335
Chief operator	410F	309
Diagrams	411D	311
Duties	421A	317
Official in charge	435B	341
Reporting circuit trouble	430H	334
Circuit-breakers: (*see also* Overcurrent protection).		
Accessibility and indicating	160	65
Cranes, cars, locomotives	382B	298
Manual operation	323F	267
Protection required	107A	39
Where required	165, 310	68, 255
Circuit switches, where required	322B	264
Circuits:		
Communication	435	341
Constant current	230B	105
Disconnected periodically	434F	340
Grounding utilization equipment	304B	250
Power, central offices	450G	351
Series, handling of	422I	326
Clearances:		
Antennas	523E, 524	367, 368
Basic:		
Vertical	232A	106
Wire—crossing	233A	114
Bridges	234D	123
Buildings	234C	120
Cables, supply	230C	105
Circuits, constant-current	230B	105
Climbing space	236	131
Buckarm construction	236F	133
Dimensions	236A, E	131, 133
Location	236A, D	131, 132
Longitudinal runs	236G	134
Miscellaneous equipment	286B	222
Ridge pin conductors	236I	135
Through conductors on cross-arms	236E	132, 133
Vertical conductors	236H, 239A	135, 143

Clearances—Continued	Rule	Page
Conductors:		
Attached to buildings	235B	130
Attached to bridges	235C	131
From bridges	234D	123
From buildings	234C	120
From conductors of another line	234A	119
From supporting structures of another line	234B	120
Lateral and vertical:		
Climbing space	239A	143
Communication wires on poles	239E, G	147, 151
Conductors not in conduit	239B	143
From supports and other wires	235A3, 239	127, 142
Mechanical protection	239C	143
Pole steps	239A	143
Power wires on poles	239D, F	144, 148
Separation	235A	129
Working space	239A	143
Neutral	230D	105
On pole lines:		
Application of rules	235A	124
Different voltages on same cross-arm	235A5	130
Line conductors, horizontal:		
Fixed supports	235A2, 3	124, 127
Suspension insulators	235A2	127
Line conductors and:		
Guy wires on same support	235A3	127
Support itself	235A3, 239	127, 142
Vertical conductors on same support	235A3, 239	127, 142
Racks, vertical	235A4	129
Open, not in conduit	237B	143
Control equipment	329C	113
Equipment, street lighting	286E	223
Fire hydrants	231A	105
General:		
Application	230	104
Constant current circuits	230B	105
Maintenance	230E	105
Metal-sheathed supply circuits	230C	105
Miscellaneous equipment on poles	286B	222
Neutral conductors	230D	105
Hand, equipment on poles	286D	222
Horizontal:		
Conductors attached to buildings	235B	130
Conductors attached to bridges	235C	131
Conductors on pole lines:		
Fixed supports	235A2, 3	124, 127
Suspension insulators	235A2	127
Conductors of different voltage on same cross-arm	235A5	130
Conductors to span or guy wires on same support	235A3	127
Conductors to supports	235A3, 239	127, 142
Conductors to vertical or lateral conductors	235A3, 239	127, 142
Pole lines	235A2	124
Supporting structures from:		
Conductors of another line	234B	120
Curbs	231C	106
Fire hydrants	231A	105
Railroad tracks	231D	106
Street corners	231B	106
Increased:		
High voltage	233B2	118
Long spans	233B1	116
Wire crossings	233 B	116
Joint use poles:		
Communication, vertical and lateral:		
In communication space	239E	147
Through power space	239G	151

	Rule	Page
Clearances—Continued		
Joint use poles—Continued		
Crossarms, horizontal	238A	137
Crossarms, not horizontal	238C	140
Line conductors	238B, D	139, 141
Power, vertical and lateral:		
In power space	239D	144
Through communication space	239F	148
Lead-in conductors	533	370, 372
Live parts	114B	45
Maintenance of	230E	105
Supply circuits of different voltage	235A5	130
Underground lines	291D	231
Vertical:		
Above ground or rails	232	106
Basic	232A	107, 109
Increases over basic	232B	110, 113
Spans longer than basic	232B	110, 112
Suspension insulators over rails	232B3	112, 113
Avoiding increases over rails	232B4	113
Voltages over 50,000	232B2	112
Transformers	286F	224
Street lights	286E	223
Power wires at underground risers	232C	113
Climbing space	236	131
Conductors attached to bridges	235C	131
Conductors attached to buildings	235B	130
Conductors and equipment	238	137
Conductors on horizontal crossarms	238B	139
Different sags	238B3	140
Different voltage	238B2	140
Same voltage	238B1	139
Conductors on nonhorizontal crossarms	238C	141
Conductors not on crossarms	238D	141
Conductors and noncurrent-carrying metal parts	238E	141
Conductors on racks	235A4	129
Conductors to supports	235A3	127
Crossarms, horizontal	238A	137
Crossings, wire	233	114
Basic	233A	114, 115
Increases over basic	233B	116, 117
Jointly used poles	239F, G	148, 151
Street light span and communication wires	238E3	142
Supply pole wiring	232C	113
Trolley span and communication wires	238E3	142
Working space	237B, C	135
Working space	237	135
Buckarms	237D	136
Dimensions	237B	135
Location	237A	135
Vertical and lateral conductors	237C, 239A	136, 143
Climbing space:		
Buckarm construction	236F	133
Location and dimensions	236A	131
Location relative to:		
Crossarms	236C	131
Supply apparatus	236D	132
Supporting structures	236B	131
Vertical and lateral conductors	239A	143
Longitudinal runs	236G	134
Near ridge-pin conductors	236I	135
Past vertical conductors	236H	135
Through conductors	236E	132
Clothing, suitable	420H	315
Collector wires, cranes	380F	296
Combustible liquid, transformers	143D	61
Communication apparatus, protective requirements	390	300

	Rule	Page
Communication circuits:		
Grades of construction	242C	157
Near supply circuits	435	341
Used in operation of supply circuits	288A	225
Communication lines, protection	287	224
Completing grounds	424D	331
Condition of switches	323D	267
Conductor:		
Clearances:		
Another line	234A	119
Not in conduit	239B	143
Fastenings	261E	185
Grounding:		
Common	93E	22
Continuity	93A	18
Current flow	92C	17
Lightning arresters, arrangement	93A	19
Material	93A	18
Mechanical protection	93C	20
Radio stations:		
Installation	563	376
Material and size	562	375
Underground	93D	21
Separation:		
Bridges	235C	131
Crossarms	238C	140
Equipment parts	238E	141
Manholes and ducts	293C	235
Underground	294	237
Vertical	235A	129
Not on crossarms	238D	141
On crossarms	238B	139
Sizes, radio antennas	523A	365
Terminals, risers from underground	297D	240
Conductors: (*see also* Cables and Cord).		
Branch connections	285B	221
Climbing space	236E, G	132, 134
Near ridge-pins	236I	135
Vertical	236H	135
Communication:		
Covering	239G2	152
Separation	239G4	152
Strength requirements	261H, J	191, 192
Vertical and lateral clearance	239E	147
Electrical protection	150	62
Elevator hoistways	380C	295
Flameproofing	151B	63
Grades of construction	242	156
Communication used with supply lines	242C	157
Constant current	242A	156
Fire alarm	242D	157
Lightning protection wires	261F3	188
Neutral conductors	242E	157
Railway feeders	242B	156
Trolley contact	242B, 261F6	156, 189
Grades B and C	242	156
Communication conductors and cables	261H, I	191
Material	261F1	187
Minimum size	261F2	188
Power cables	261G	190
Sags and tensions	261F4	189
Splices and taps	261F5	189
Grade D:		
Inspection	213	95
Material and size	262I	201
Messengers	262J	203
Paired conductors	262I3	202
Sags	262I4	202
Splices and taps	262I5	203

Conductors—Continued — Rule — Page
- Grade N:
  - Communication — 263I — 208
  - Lightning wire — 263F — 208
  - Line, material and size — 263D — 205
  - Service:
    - Cabled — 263E4 — 207
    - Material and size — 263E — 206
    - Sag, open wire — 263E3 — 207
    - Trolley contact — 263G — 208
- Grounding:
  - Attachment points for — 92 — 16
  - Capacity and size — 93B — 19
  - Continuity and material — 93A — 18
  - Current flow in — 92C — 17
  - Mechanical protection — 93C — 20
  - Multiple use — 93E, 97A, 285C — 22, 27, 221
  - Scope and application of rules — 90, 91 — 15
  - Underground — 93D — 21
- Ground used as one conductor of circuit — 215C — 97
- Guarding — 153, 313, 380B — 64, 260, 294
  - Hazardous locations — 314 — 260
- Identification — 285A, 312 — 221, 257
  - Manholes — 298 — 240
- Identified appliances, portable — 373 — 291
- Isolation — 152 — 64
- Joints and ends — 155 — 65
- Lead-in — 530, 541 — 370, 373
  - Clearances — 533 — 370
  - Installation — 533 — 371
  - Material — 531 — 370
  - Size — 532 — 371
  - Spacings — 542 — 373
- Levels on various classes of lines — 220 — 98
  - Preferred levels:
    - Power and communication lines — 220B — 98
      - Exceptions:
        - Minor extensions — 220B2 — 99
        - Small power circuits — 220B3, 232A, 238B — 99, 109, 139
    - Power lines of different voltages — 220C2 — 102
  - Standardization, general — 220A — 98
- Lightning protection — 261F3 — 188
- Loading — 251 — 163
- Mechanical protection — 311 — 97
- Neutral, common use — 285C — 221
- Overload — 285 — 221
- Protection — 310 — 255
  - Against injury — 151A — 63
  - Manholes and ducts — 295 — 238
  - Risers from underground — 297 — 239
  - Underground — 294 — 237
- Sags and tensions — 261F4 — 189
- Span lengths — 252D — 168
- Splices — 316 — 261
- Strength requirements — 262I — 201
- Supply:
  - Clearances — 239F — 148
  - Installation — 239F2 — 149
  - Separation — 239F4 — 151
  - Sizes — 261F2 — 188
  - Strength requirements:
    - Grades B and C — 261F — 187
    - Grade N — 263D — 205
- Supports — 151C — 64
  - Unusual — 280C — 215
  - Thermal damage — 151 — 63

	Rule	Page
Conductors—Continued		
Trolley:		
Construction	289	228
Sizes	261F6	189
Vertical:		
Mechanical protection of	239C	143
Separation	238	137
Vertical and lateral:		
Clearance	239	142
Location	239A	143
Working space	237C	136
Conflicts:		
Antennas and supply circuits	524C	369
Avoidance of, supply lines	221	103
Conductor construction	242A, B	156
Lines	241E	155
Structure construction	241E	156
Connections:		
Changeable	364	288
Overhead	285B	221
Connectors, cable:		
Design	372B	290
Disconnection	372	290
Live parts	372C	291
Strain relief	372D	291
Connectors, portable	373B	291
Constant-current circuits	242A	156
Construction:		
Antennas, radio	523	364
Grades	240	153
Lines	210	94
Control circuits, mechanical protection	120F	52
Control devices for motors	340	281
Control equipment:		
Enclosures	329	271
Guarding live parts	329G	274
Location	329J	276
Marking	329F	273
Open-phase protection	329M	277
Overcurrent protection	329K	276
Phase reversal protection	329M	277
Protection for workmen	329H	275
Rating	329E	273
Under voltage protection	329L	277
Control of emergency and exit lights	320C, D	262
Control of movement:		
Locking handles	383A	299
Cranes, cars, elevators, locomotives	382	299
Counterpoise wires:		
General requirements	521B	363
Cord (*see also* Cables and Conductors).		
Cord, flexible:		
Defective	374E	292
Hazardous locations	374C	292
Joints	374D	292
Strain relief	374D	292
Telephone	391B, C	302
Cradles at power line crossings:		
Grades B and C	261L	194
Grade N	263H	208
Cranes:		
Circuit-breakers	382B	298
Collector wires	380F	296
Control of movement	383	299
Disconnecting means	382A	298
Switches	382B	298
Crossarms:		
Bracing	280B2	215

Crossarms—Continued	Rule	Page
Climbing space	236C	131
Dimensions	261D4	184
Grades of construction required	243B	160
Grades B and C:		
Braces	261D2	182
Double crossarms, where required	216D5	184
Location on pole	261D6	185
Longitudinal strength:		
Dead ends	261D3	183
Ends of higher grade construction	261D3	183
Ends of transversely weak sections	261D3	183
General	261D3	182
Methods of meeting requirements	261D3	183
Size	261D4	184
Vertical strength	261D1	182
Grade D:		
Double crossarms, where required	262D3	200
Material	262D1	199
Size	262D2	199
Grade N	263C	205
Location	280B1	215
Separation	238A	137
Crossings:		
Insulators	278	211
Line	241D	154
Curbs, clearance from	231C	106
Current flow, grounding conductor	92C	17
Current-carrying part, guarding	214A	96
Current-transformers:		
Short-circuiting	140A	59
Secondaries	431E	335
Damp locations, guarding conductors	314	260
Danger signs	411I	313
Dangerous conditions:		
Reporting	451I, 452F	356, 358
Tunnels	437B	344
Dead-front panelboards and switchboards	335D	279
Definitions of special terms		2
Index		1
Design of lines	210	94
Diagrams for chief operator	411D	311
Direct-current systems, grounding	92A	16
Direct-current circuits	93B1	19
Disconnecting means, cranes	382A	298
Disconnection:		
Temporary wiring	322D	265
Automatic fuses	324A	267
of Circuits, periodically	434F	340
of Equipment, protection	308	254
Disconnectors:		
Accessibility	323B	266
Capacity	164, 323B	67, 266
Cranes, cars, locomotives	382C	298
Lightning arrester circuits	181	74
Locks for	328B	270
Opening	423C	327
Protecting workmen	421I	322
Working space, lightning arresters	181B	74
Distribution of rules	440	347
Ducts:		
Construction	291	230
Dissipation of heat	291H	233
Lateral, sealing	291G	233
Electric railway, overhead construction	289	228
Electrical protection, conductors	150	62
Elevated positions, working in	430F	333
Eliminators, insect	376	294

	Rule	Page
Elevator hoistways, guarding live parts	380C	295
Elevators:		
Control of movement	383	299
Signal circuits	380C	295
Emergency equipment	111C	41
Emergency installations	301C	248
Emergency lighting:		
Cars and subways	384	300
Control	320C	262
Supply stations	103B	36
Emergency methods	420A	313
Emergency rules	441	348
Emergency stop switches	322E	265
Employees:		
Inexperienced, communication systems	450B	349
Instructing	442	348
Instructions	411E	311
Qualifications	443	349
Enclosed switches:		
Locks for	328A	270
Operation	328D	271
Enclosures:		
Control equipment	329A	271
Covers	329D	273
Material	329B	272
Enforcement of rules	440	347
Equipment:		
Emergency	111C	41
Grounding	92D	18
Grounding conductor	97A4, 5	28
Size and capacity	93B5, 6	20
Idle	111B	41
Killing	423	327
New	111D	41
On poles	286	222
Operation, application of rules	401	307
Portable:		
Grounding	381B	297
Outdoor	375	293
Regular	111A	41
Scope of rules	400A	307
Separation of conductors	238E	141
Street lighting	286E	223
Suddenly moving parts	380G	297
Supply, avoidance	450C	350
Touching	435E	342
Communication systems	451E	354
Equipment, dead:		
Applying grounds	422H	326
Connecting wires	422H	326
Permission to work	423E	328
Proceeding with work	423G	329
Removal of tags	423J	330
Reporting clear	423I	329
Restoring service	423K	330
Exits	105	38
Exit lights, control	320C, D	262
Exposed, communication lines	402	308
Falling objects, overhead lines	433I	339
Fastenings, conductor	243C	160
Fire extinguishers	106, 420K	38, 316
Fire hydrants, clearances from	231A	105
Fire-alarm conductors	242D	157
First-aid rules	410C	309
Fixtures, lighting:		
Grounding	360	286
Live parts	362	287

	Rule	Page
Fixtures—Continued		
Polarizing lampholders	360C	286
Supply stations	103C	36
Flameproofing, conductors	151B	63
Flames, avoiding in manholes	436E, 452D	343, 357
Floor toe boards	104F	38
Floors	104A	37
Battery rooms	135	58
Foreman:		
Duties	421B, 450E	317, 351
Testing	432D	336
Form of rules	440B	348
Foundations, strength requirements	261B	180
Furnaces, electric:		
Grounding of frames	351	284
Guarding of glowing parts	350	284
Fuses (*see also* Overcurrent protection):		
Accessibility	160	65
Arrangement of switchboards	336	279
Automatic disconnection	324A	267
Disconnection	166, 322C	69, 265
Grounded conductors	150B	63
Handling	430D, 450H	333, 352
Indicating	160	65
Location	325	269
Removing	174B	72
Tunnels	437J	346
Where required	165, 310	68, 255
Future inspections, utilization equipment	302B	249
Gas, testing for	452B	357
General requirements for overhead and underground lines.	210	94
Construction	210	94
Design	210	94
Grounding of circuits and equipment	215	96
Methods	215A	96
Urban districts, parts to be grounded	215B	97
Use of ground wire as one conductor of circuit	215C	97
Inspections:		
Lines of service	213A	95
Lines out of service	213B	95
Maintenance	211	95
Switches, arrangements	216	97
General requirements:		
Protective arrangements	110	41
Supply stations	102	34
Grades of construction	240, 241	153
Conductors	242	156
Crossings, multiple	241D3	154
Crossings, normal	241D	154
General	240	153
Order of grades	241C	153
Short span	261K	193
Two or more conditions	241B	153
Ground clamps, how attached	95B	25
Ground connections:		
Artificial grounds	94C	23
Contact surfaces	95C	25
Metal structures	94B	23
Piping systems	94A	22
Protective	424B	330
Radio stations	570	376
Railway return	94D	24
Ground detectors	145	62
Ground resistance	96A, B	27
Grounding:		
Alternating-current systems	92B	16
Apparatus on passenger cars	380E	296

	Rule	Page
Grounding—Continued		
Artificial electrodes	97B	28
Auxiliaries	122C	54
Circuits	215	96
Equipment	304B	250
Communication apparatus	392	302
Conductors:		
Radio stations	561	375
Installation	563	376
Material and size	562	375
Conductor:		
Attachment point	92	16
Capacity	93B	19
Continuity	93A	18
Covering	239G	152
Current flow in	92C	17
Material	93A	18
Mechanical protection	93C	20
Multiple use	93E, 97, 285C	22, 27, 221
Size	93B	19
Underground	93D	21
Conductors:		
Artificial electrodes	97B	28
Capacity	93B	19
Common	93E	22
Continuity	93A	18
Current flow	92C	17
Equipment	97A4, 5	28
Guarding against contact	93C	20
Instrument transformers	97A3	28
Lightning arresters	97A1	28
Arrangment	93A	19
Lightning rods	97A6	28
Material	93A	18
Mechanical protection	93C	20
Point of attachment	92	16
Power circuits	97A2	28
Separate conductors, where required	97A	27
Size	93B	19
Underground	93D	21
Connection, lightning arrester	97C	28
Continuity	95A, C	24
Coupled machines	122B	54
Devices	163	67
Direct-current distribution systems	92A	16
During repairs	113C	43
Electrodes	392	302
Equipment	92D, 215	18, 96
Portable	381B	297
Outdoor	375D	294
Fixtures, lighting	360A	286
Frames	381	297
Furnaces	351	284
Motors	344	283
Panelboards and switchboards	334	278
Ground resistance, limits	96	27
Guys	282H	218
Hazardous locations	117B	50
Instrument cases	177	73
Instrument transformers	141	60
Lightning arrester cases	183	75
Machine frames	122	53
Means:		
Artificial ground, electrodes	95D	26
Ground clamps	95B	25
Radio stations	572, 573	377, 378
Metal frames	124B	55

	Rule	Page
Grounding—Continued		
Metal parts	168, 326	60, 269
Appliances, portable	371	289
Equipment	304C	250
Metal parts of signs	363C	287
Method:		
Equipment	304A	249
Piping	95A	24
Motor frames	342B	282
Parts, metal	381	297
Protective	113	42
Application of rules	91	15
Emergency	91D	16
Scope of rules	90	15
Temporary installations	91C	16
Waiver of rules	91A	15
Raceway	92D, E	18
Riser pipes	297C	239
Rules:		
Application	91	15
Scope	90	15
Waiving	91	15
Service conduit	92E	18
Supports of lamps in series	365C	288
Switch enclosures and handles	328E	271
Switchboards	175	72
Telephone apparatus	392	302
Transformers	142	60
Waterpiping system, point of attachment	95A	24
Wires:		
Jointly used poles	239F	148
Mechanical protection	239C	143
Supply	239F	150
Grounds:		
Artificial	94C, 95D	23, 26
Metallic underground	94B	23
Multiple use	97C	28
Piping systems	94A, 95A, C	22, 24, 25
Protective	424	330
Completing circuits	424D	331
Overhead lines	423F	328
Stations	423D	328
Switchboards	175	72
Radio stations	571	377
Guarding:		
Antennas	525	370
Arcing parts	329I	275
Lightning arresters	184	75
Belts	112	42
Conductors	153, 313	64, 260
Hazardous locations	154	65
Equipment on poles	286C	222
Glowing parts	350A	284
Lines	214	96
Live parts	114, 118, 121, 169, 176, 327, 329G, 380A, B.	43, 50, 53, 70, 73, 269, 274, 294
Furnaces, electric	352	285
Lightning arresters	184	75
Manholes	296	239
Motors	343	283
Panelboards and switchboards	335	278
Telephone apparatus	391	301
Utilization equipment	306	253
Manholes	436B, 452 A	342, 356
Parts on car roofs	381C	298
Pulleys	112	42

	Rule	Page
Guarding—Continued		
Shaft ends	112	42
Suddenly moving parts	112, 325	42, 269
Trolley-contact conductors	289E	229
Guards:		
Guys	282E	217
Material	380D	295
Guides, qualified	421C	318
Guying	282	216
Guys:		
Anchor rods	282G	218
Antenna	523C	366
Fastenings	282D	217
Grades B and C:		
Angles	261C5	182
General requirements	261C	180
Strength requirements	261C5	181
Grade D:		
General requirements	262C	196
Maintenance	262C5	199
Strength requirements	262C3, 4	199
Grade N	263B	204
Grounding	282H, 283B4	218, 219
Guards	282E	217
Insulation from metal poles	272F	217
Insulators:		
Material	283A1	218
Required locations	283B	219
Strength	283A	218
Point of attachment	282C	217
Span wire insulators	284B	220
Handling switchboard equipment	430G	333
Handrails, motors	343C	283
Hardware, protective coverings	261M	194
Hazardous locations	321	263
Appliances, portable	374C	292
Enclosure of parts	117A	50
Grounding	117B	50
Grounding metal parts	304C3	251
Guarding conductors	154, 314	65, 260
Motors	125B, 341	55, 282
Panelboards	337E	281
Utilization equipment	307	254
Headlights, removable	380H	297
Heating appliances, battery rooms	138B	59
Ice loading on conductors	251	163
Identification:		
Apparatus in manholes	299	241
Circuits	411J	313
Conductors and terminals	312	257
Equipment	119, 309	50, 255
Poles	280A6	214
Switchboards	173	71
Illumination:		
Battery rooms	138	59
Supply stations	103	35
Switchboards	171	71
Wiring for	156	65
Impedors, portable equipment	375E	294
Inclosure of switches	323E	267
Inductance, precaution against	315	260
Inexperienced employees:		
Supply systems	420C	314
Communication systems	450B	349
Insect eliminators	376	294
Inspection:		
Lines and equipment	213	95

Inspection—Continued	Rule	Page
Portable cables in tunnels	437H	346
Protective devices	411G	312
Inspections	111	41
Utilization equipment	302B	249
Installation	355	285
Lightning arresters	355	285
Lines	211	95
Overcurrent protective devices	320	261
Switches	320	261
Instructing employees	410D, 411E, 442	309, 311, 348
Instrument:		
Cases, grounding	177	73
Transformers, grounding conductors	93B3, 97A3	19, 28
Instruments:		
Location of	330B	277
Switchboards	172	71
Insulating:		
Control equipment	329H	275
Guards, grounding	93C	21
Mats	114C, 306B	47, 253
Motors	343B	283
Panelboards and switchboards	335A	279
Where required	327C	270
Insulation:		
Appliances, portable	370	289
Batteries	133	57
Insulators	523B	365
Antenna	523B	365
Crossings	278	211
Electrical strength	272	209
Factory tests	275	209
Grade of construction	243C	160
Grade B:		
Constant current circuits	276A	210
Dry flashover voltage	274	209
Factory tests	275	209
Material and marking	271	208
Operating conditions	276C	210
Protection against arcing	277	211
Puncture voltage	273	209
Requirements, methods of meeting	278	211
Strain position	272	209
Grade D	262G	200
Guy:		
Material and strength	283A	218
Required locations	283B	219
Guys	283	218
Neutral conductors	242E	157
Protection against arcing	277	211
Selection	276	210
Span wire	284B	220
Street light suspension ropes	286E5	224
Test voltages	274	209
Intent of rules, utilization equipment	301B	248
Interpretation of rules	440C	348
Interpretation, rules for employees	410A	308
Interrupting capacity, switches	323A	266
Isolation	152	64
Conductors	152	64
Lines	214	96
Metal parts	113B	42
Isolation by elevation:		
Lamps in series	365B	288
Utilization equipment	305D, 306A	252, 253
Joint use, antennas and supply circuits	524B	368
Joint use of poles by power and communication	222	103

	Rule	Page
Jointly used poles, loading	252C2	167
Joints	155	65
Conductors	155	65
Manholes	296A	239
Cord, flexible	374D	292
Taped	431B	334
Killing equipment and lines	423	327
Workman's request	423B	327
Ladders, continuity	104E	37
Lampholders, insulating coverings	371B	290
Lamps, arc, access to	366	288
Lamps in series:		
Circuits	365	288
Bridging	434D	340
Grounding of supports	365C	288
Handling	434C	340
Street	434	339
Levels of conductors	220	98
Preferred levels:		
Power and communication lines	220B	98
Exceptions	220B2	99
Minor extensions	220B2	99
Small power circuits	220B3, 232A, 238A	99, 109, 139
Power lines of different voltage	220C	102
Standardization general	220	98
Lighting	384	300
Lightning arresters	94C1	23
Artificial grounds	94C1	23
Disconnectors	181	74
Grounding of cases	183	75
Grounding conductors	97A1	28
Arrangement	93A	19
Size and capacity	93B4	19
Installation of	355	285
Insulation of attachments	184C	289
Interconnection	97C	28
Oil-filled	107D	41
Radio receiving stations	551A	374
Where required	180	73
Lightning protection wires	263F	208
Lightning rods, grounding conductor	97A6	28
Limit switches, cranes and elevators	383C	299
Line:		
Construction, order of grades	241C	153
Crossings, grades of construction	241D	154
Insulators	270	208
Supports, loading	252	164
Lines:		
Communication:		
Exposed	402	308
Operation	400B, 401	307
Protection	287	224
Stringing	451G	355
Dead:		
Procedure for other gangs	423H	329
Proceeding with work	423G	329
Removal of tags	423J	330
Reporting clear	423I	329
Restoring service	423K	330
Killing	423	327
Levels:		
Preferred	220B1	98
Relative	220B, C	98, 102
Overhead	451	352
Protective grounds	423F	328
Standardization of levels	220A	98

	Rule	Page
Lines—Continued		
Stringing	435F	342
Supply:		
Approaching	435D	341
Avoiding contact	451D	353
Care	451F	354
Operation	400A, 401	307
Supply and communication:		
Accessibility	212	95
Arrangement of switches	216	97
Avoidance of conflict	221	103
Design and construction	210	94
Exemptions	201	93
Grounding	215	96
Guarding	214	96
Inspection and tests	213	95
Installation and maintenance	211	95
Isolation of	214	96
Joint use of poles	222	103
Minimum requirements	202	94
Scope of rules	200	93
Separate poles	223	104
Underground	436	342
Communication	452	356
Location	290	230
Live equipment	422	322
Live parts:		
Access to	121B	53
Adjustments, lightning arresters	184B	75
Battery rooms	137B	59
Brushes	430D	333
Connectors, cable	372C	291
Elevator hoistways	380C	295
Fixtures, lightning	362	287
Guarding	114, 121, 124, 169, 176, 327, 329G, 380A, B.	43, 53, 55, 70, 73, 269, 274, 294
Battery rooms	137	58
Furnaces	352	285
Lightning arresters	184	75
Manholes	296	239
Motors	343	283
Panelboards and switchboards	333, 335	278, 279
Telephone apparatus	391	301
Handling	450F	351
Tunnels	437G	345
Overhead lines	433F	337
Precautions	420F	315
Protection of workmen	329H	275
Repairing, tunnels	437G	345
Shielding	118	50
Signs	363B	287
Spacings	174	72
Supply stations	430C	332
Test of circuit	424C	330
Testing	431C	334
Touching	422A, 433G	322, 338
Tunnels	437C	344
When to kill parts	422E	33
Work from below	422G	326
Work on	116	49
Loading, grades B, C, and D	251	163
Conductor	251	163
General map	250	161
Line supports	252E	168
Longitudinal	252E	168

Loading, grades B, C, and D—Continued Longitudinal—Continued	Rule	Page
Application of loads	252E	168
Dead ends	252C3	167
General	252C	166
Jointly used poles	252C2	167
Span lengths	252D	168
Transverse	252B6	166
Angles	252B6	166
Application of loads	252E	168
Flat surfaces	252B5	166
General	252B	165
Trolley contacts	252B4	166
Vertical	252E	168
Application of loads	252E	168
General	252A	164
Loading map	250	162
Locking, switches	216C, 323C	98, 266
Locomotives, control of movement	383	299
Longitudinal loading, line supports	252C	166
Low-voltage protection, rotating equipment	120D	52
Machine frames, grounding	122	53
Machines, speed control	120	51
Maintaiuing service	421G	320
Maintenance:		
Clearances	230E	105
Lines	211	95
Manholes	436E	343
Avoiding flames	436E	343
Construction	292	234
Duct entrances	291F	133
Guarding	436B, 452A	342, 356
Pulling cables	436F	343
Testing for gas	436C	343
Underground lines	290C	230
Unidentified cables	436G	343
Watchman	436D, 452C	343, 357
Manual operation, power switches	323F	267
Marking:		
Control equipment	329F	273
Equipment	119	50
Overcurrent protective services	320	261
Panelboards	337C	280
Rating equipment	309	255
Switch terminals	324B	268
Switches	320, 328C	261, 271
Material, switchboards	171	71
Mats, insulating	306B, 343B	253, 283
Mechanical protection	311	257
Conductors	311	257
Near ground	239C	143
Grounding condutor	93C	20
Messages, repeating	420L	316
Messengers	262J	203
Metal parts	326	269
Equipment	304C	250
Grounding of	168, 326	70, 269
Metal structures, ground connections	94B	23
Meters	431	334
Motors:		
Adjustable speed	120E	52
Control	125A	55
Control devices	340	281
Exposed to dust	125C	55
Grounding:		
Frames	342B, 344	282, 283
Live parts	343	283
Hazardous locations	125B, 341	55, 282
Insulating mats	343B	283

	Rule	Page
Motors—Continued		
Marking	119B	51
Protection for wiring	342	282
Protecting moving parts	345	284
Speed control	120	51
Speed limitation	340A	281
Steps and handrails	343C	283
Under-voltage protection	340D	282
Wooden floors	125D	56
Moving parts, supply stations	430C	332
Neutral, overhead conductors	285C	221
Oil-filled apparatus	107	39
Openings, switch enclosures	328F	271
Open-phase protection	329M	277
Operating routines	421	317
Operation:		
Application of rules	401	307
Switches	328D	271
Organization diagram	410B	309
Overcurrent protection: (*see also* Fuses and Circuit-breakers).		
Accessibility, marking and installation	320	261
Arrangement	160A	65
Conductors	150	62
Control equipment	329K	276
Equipment	310	255
Hazardous locations	321	263
Location	329	269
Where required	165	68
Overhead lines	433, 451	336, 352
Panelboards:		
Accessible control	330	277
Arrangement of fuses	337	280
Grounding of frames	334	278
Guarding live parts	333	278
Hazardous locations	337E	281
Isolation by elevation	335	278
Location in residences	337F	281
Marking	337C	280
Material	337B	280
Protection against moisture	337D	281
Parts on car roofs, guarding	381C	298
Parts, metal, grounding of	381	297
Parts, suddenly moving, equipment	380G	297
Passageways	104B	37
Permission to work	423E	328
Person in charge, testing	432D	336
Phase-reversal protection	329M	277
Physicians, address list	441	348
Pins	243C	160
Grade of construction	243C	160
Grades B and C, longitudinal strength:		
Angles	261E4	187
Conflicts	261E4	187
Dead ends	261E1, 4	185, 187
Ends of higher grade construction	261E1	185
Ends of transversely weak sections	261E1	185
General	261E1	185
Joint Use	261E4	187
Method of meeting requirements	261E1	186
Height	261E3	186
Grade D	262F1	200
Material	262F1	200
Size	262F3	200
Strength	262F2	200
Piping systems, ground connections	94A	22
Plug-type switchboards, guarding live parts	335C	279
Polarizing lampholders and fixtures	360C	286

	Rule	Page
Pole:		
Locations, crossings	362A4	195
Obstructions	280A7	215
Settings	262B	196
Steps	239A, 280A5, 433C, 451B	143, 214, 337, 353
Poles	451A	352
Construction features	261A	172
Crossings, location	262A8	196
Equipment on	286	222
Miscellaneous	286	222
Street lighting	286E	223
Transformers	286F	224
Fiber stresses	261A3	175
Flexible supports	261A6	179
Grade of construction required	243A	159
Grades B and C	261A3	176
Defects	261A3	176
Flexible supports	261A6	179
Foundations	261B	180
Guys, use of	261C	180
Minimum size	261A4	176
Spliced and stub reinforced	261A4	176
Strength requirements	261A2	169
Concrete poles	261A2	169
General	261A	169
Wood poles	261A7	179
Angles	261A7	179
Dead ends	261A4	173
Longitudinal	261A4, 6	173, 174, 178
Transverse	261A4, 5	173, 175, 177
Vertical	261A4, 5	173, 175, 177
Grade D	262B	196
Foundations	262B	196
Freedom from defects	262A5	195
Locations at crossings	262A4, 8	195, 196
Minimum size	262A6	196
Spliced and stub reinforced	262A7	196
Strength requirements	262A2	194
Guyed poles	262A2	194
Methods of providing	262A3, 262C3, 4	195–199
Unguyed poles	262A1	194
Grade N	263A	204
Guarding	280A2	213
Guying	282	216
Identification	280A6	214
Joint use, general	222	103
Jointly used, clearances	239E, F, G	147
Metal, grounding	215B, 280A4	97, 214
Obstructions and rubbish	280A1, 7	213, 215
Pole steps	280A5	214
Precautions before climbing	435C	341
Protection	280A2	213
Separate lines, general	223	104
Splicing	262A7	196
Strength requirements:		
Grades B and C	261A	169
Grade D	262A	194
Grade N	263A	204
Testing before climbing	433B	336
Warning signs	280A3	213
Portable cables, inspection, tunnels	437H	346
Portable conductors, disconnection of	322D	265
Portable devices, handling, tunnels	437I	346

	Rule	Page
Portable equipment, grounding conductor, size, and capacity.	93B6	20
Power lines for communication circuits	288B	227
Power supply, radio stations	581	378
Precautions:		
Climbing poles	435C	341
Climbing structures	451A	352
Precautions, general	450	349
Communication systems	450	349
Employees	420	313
Tunnels	437M	347
Protecting:		
Traffic	421H, 451H	321, 356
Overhead lines	433H	328
Workmen	421I	322
Protection by disconnection	308	254
Protection for exposed overhead lines	287	224
Protective:		
Clothing	350B	284
Covering, metal parts	261M	194
Devices	444	349
Inspection	411G	312
Operation	411F	311
Radio, application of rules	550	374
Radio receiving stations	551	374
Transmitting stations	552	374
Grounding	113	42
Grounds	424	330
Overhead lines	423F	328
Removing	424E	331
Stations	423D	328
Switchboards	175	72
Methods, operation	411	311
Requirements, telephone apparatus	390	300
Pulleys, guarding	112	42
Pulling cables	452E	358
Manholes	436F	343
Qualifications of employees	410E, 443	309, 349
Raceway:		
Grounding	92D, E	18
Grounding conductor, size	93B5	20
Radio:		
Antennas, application of rules	520	362
Installations	510	361
Classification of stations	510	361
Scope of rules	500	361
Protective devices	550	374
Stations	572, 573	377, 378
Grounding means	572, 573	377, 378
Grounds	571	377
Power supply, application of rules	580	378
Railings	104C	37
Railroad tracks, clearance	231D	106
Railway feeders, construction grades	242B	156
Rating:		
Control equipment	329E	273
Radio installations	510B	361
Receiver cords, guarding	391B, C	302
Receptacles:		
Location	374B	292
Type required	361	287
Reference to other codes	303	249
Relative levels, lines	220B, C	98, 102
Relays, equipment, portable, outdoor	375C	293
Removal of tags, equipment and lines	423J	330
Removing grounds	424E	331

	Rule	Page
Requirements, general	521	362
Radio antennas	521	362
Rules for employees	410	308
Reporting:		
Clear, equipment and lines	423I	329
Dangerous conditions	435G, 451I, 452F	342, 356, 358
Tunnels	437N	347
Defects:		
Manholes	436I	344
Meters	431G	335
Overhead lines	433K	339
Series lamps	434G	340
Switchboards	430I	334
Testing	423G	336
Trouble	430H	334
Responsibility of operation	410G	310
Restoring service	421E	319
Equipment and lines	423K	330
Rheostats, location	144	62
Rotating equipment, speed control	120	51
Rubbish	280A1	213
Rules for employees:		
General requirements	410	308
Rules for installation of lines	201	93
Application	201	93
Waivers	201C	94
Requirements, minimum	202	94
Scope	200	93
Safe supports	450D	350
Safety appliances	420G	315
Safety belts	420J, 450D	316, 350
Safety interlock, switchboards	336	279
Sag, services, open wire	263E3	207
Sags:		
Grade D construction	262I4	202
Separation of conductors	235A2	126
Sags and tensions, supply conductors	261F4	189
Scope:		
Grounding rules	90	15
Supply equipment	100	33
Scope of rules:		
Electric equipment, operating	400A	307
Equipment, portable, outdoor over 750 volts	375A	293
Lines, installation and maintenance	200	93
Radio installations	500	361
Supply lines, operating	400A	307
Utilization equipment	300	247
Separation:		
Conductors on crossarms	238C	140
Duct systems	291E	232
Vertical		
Conductors and equipment	238A, B, D, E	137, 139, 141
Series circuits:		
Handling	422I	326
Lamps	365	288
Precautions	434B	339
Series lamps	434	340
Service, maintaining	421G	320
Service conduit, grounding	92E	18
Service switches, where required	322A	263
Shaft Engs, guarding	112	42
Shielding, live parts	118	50
Short-circuiting, current transformers	140A	59
Side guying of poles	261A5	177
Signal circuits, elevator hoistways	380C	295

	Rule	Page
Signs:		
Accessibility	363A	287
Connections, changeable	364	288
Control	363D	287
Danger	411I	313
Grounding metal parts	363C	287
Live parts	363B	287
Warning	411H	313
Spacings, antenna lead-in	542	373
Span lengths, longitudinal loading	252D	168
Special tools	431F	335
Specialized work, supply stations	430	331
Speed control, rotating equipment	120	51
Splices:		
Grades B and C	261F5, 261G1	189, 190
Grade D	262I5	203
Splicing live cables	436H	344
Spurs	433E, 451C	337, 353
Stair guards	104D	37
Stair toeboards	104G	38
Standing on ground, tunnels	437E	345
Stations, radio, application of rules	540	373
Stations, supply:		
Battery rooms	430E	333
Care about machines	430B	331
Live parts	430C	332
Moving parts	430C	332
Specialized work	430	331
Steps, motors	343C	283
Steps, pole	280A5	214
Storage batteries:		
General	130	56
Installation of	353	285
Insulation	133	57
Isolation	131	57
Racks and trays	134	58
Ventilation	132	57
Strain relief:		
Connectors, cable	372D	291
Cord, flexible	374D	292
Street corners, clearances	231B	106
Strength requirements:		
Conductor fastenings	261E	185
Conductors:		
Grades B and C	261F	187
Grade D	262I	201
Grade N	263D	205
Crossarms:		
Grades B and C	261D	182
Grade D	262D	199
Grade N	263C	205
Foundations	261B	180
Guys:		
Grades B and C	261C	180
Grade D	262C	196
Messengers	262J	203
Pins	262F	200
Poles:		
Grades B and C	261A	169
Grade D	262A	194
Grade N	263A	204
Supply services	263E	206
Stringing wires	435F	342
Communication lines	451G	355
Overhead lines	433J	339
Structures, supporting	243	159
Subways	437	344

	Rule	Page
Suddenly moving parts:		
Guarding	112	42
Shielding of	167	69
Supervision of workmen	420D	314
Supply:		
Cables	241A	153
Circuits	242E	158
Communication circuits	288B	227
Radio	526	370
Electrical, cranes, etc	382	298
Equipment:		
Application of rules	101	33
General requirements	110	41
Scope	100	33
Waiving of rules	101	33
Lines, short span crossing	261K	193
Services	263E	206
Stations:		
Emergency lighting	103B	36
Rooms and spaces	102	34
Wires, avoiding	450C	350
Supports:		
Antenna, radio	523C	366
Safe	420I, 450D	316, 350
Switch frames, guarding	121C	53
Switchboards:		
Accessible control	330	277
Accessibility	170	70
Arrangement	173, 332	71, 277
Arrangement of fuses	336	279
Grounding	175	72
Grounding of frames	334	278
Guarding of	114C	48
Guarding live parts	333	278
Handling	430G	333
Identification	173, 332	71, 277
Illumination	171, 331	71, 277
Instruments	172	71
Isolation by elevation	335	278
Location	170, 331	70, 277
Safety interlock	336	279
Specialized work	430	331
Switches:		
Accessibility and indication	160	65
Marking	320	261
Alinement	164D	68
Arrangement	324B, 330	268, 277
Capacity	164	67
Circuit, where required	322B	264
Condition	323D	267
Connection	327D	270
Crane, car, locomotive	382B	298
Disconnecting fuses	322C	265
Emergency stop	322E	265
Enclosed	323E	267
Enclosing	327B	270
Enclosures	329A	271
Grounding	328E	271
Unused openings	328F	271
Guarding live parts	327	269
Interlocked	324C	268
Interrupting capacity	323A	266
Oil, isolation	161	66
Live load	324C	268
Locking	164B	67
Blocking	323C	266
Locks for	328A	270
Marking	328C	271

	Rule	Page
Switches—Continued		
Opening circuits	431D	334
Opening and closing	422F	325
Operation	328D	271
Power operated, manual operation	323F	267
Protecting workmen	421I	322
Service, where required	322A	263
Signs	363D	287
Special circuits	320B	292
Tunnel	437J	346
Uniform position	216D	98
Where required	162, 310, 322	66, 255, 263
Tables:		
PART 1		
1. Illumination intensities	103A	36
2. Minimum clearance from live parts	114A	45
PART 2		
1. Minimum vertical clearance of wires above ground or rails.	232A	108
2. Clearance above ground for open supply wiring	232C	113
3. Wire-crossing clearances	233A	115
4. Clearances of supply conductors from buildings	234C	122
5. Clearances from bridges	234D	123
6. Minimum horizontal separation at supports between line conductors of the same or different circuits.	235A	125
7. Separation in inches required for line conductors smaller than No. 2 AWG.	235A	126
8. Separation in inches required for line conductors No. 2 AWG or larger.	235A	127
9. Minimum clearances in any direction from line conductors to supports, and to vertical or lateral conductors, span or guy wires attached to the same support.	235A	128
10. Minimum horizontal dimensions of climbing space.	236E	133
11. Vertical separation of crossarms carrying conductors.	238A	138
12. General clearances	239D	145
13. Grades of construction for communication conductors crossing over rairoad tracks and supply lines.	241D	155
14. Grades of construction for supply conductors alone, at crossings, at conflicts, or on the same poles with other conductors.	242A	156
15. Grades of construction for communication conductors alone, or in upper position at crossings, at conflicts, or on joint poles.	242E	158
16. Minimum overload capacity factors of completed structures.	261A	171
17. Thickness of steel	261A	172
18. L/R for compression members	261A	172
19. Ultimate fiber stresses of wood poles	261A	175
20. Allowable percentages of ultimate stress for treated or untreated poles under vertical and transverse loading.	261A	176
21. Cross arm cross sections	261D	184
22. Minimum over-all conductor sizes	261F	188
23. Strength (in pounds) of head guys required for loading districts indicated.	262C	198
24. Minimum wire sizes	262I	201
25. Stringing sags	262I	202
26. Minimum sizes of messengers	262J	203
27. Grade N minimum sizes for supply-line conductors.	263D	205

Tables—Continued

PART 2—Continued

	Rule	Page
28. Minimum sizes of service leads carrying 750 volts or less.	263E	206
29. Sags for open-wire services	263E	207
30. Test-voltage requirements	274	209

PART 3

	Rule	Page
1. Thickness of inclosures	329B	272
2. Air spaces in controllers	329I	276

PART 5

	Rule	Page
1. Antenna conductor sizes—ordinary construction	523A	365
2. Minimum antenna clearances above ground or roof.	523E	368

	Rule	Page
Tagging circuits	421F, 423C	320, 327
Taped joints	431B	334
Telephone apparatus, protective requirements	390	300
Temporary installations, utilization equipment	301C	248
Temporary wiring:		
Disconnection	322D	265
Tunnels	437L	346
Temporary installations, waiving rules	201C	94
Terminal bases, material	123A	54
Terminals, identification	312B, C	258, 259
Testing	432	335
Authorization for work	432B	335
Series lamp circuits	434E	340
Testing for gas	452B	357
Manholes	436C	343
Testing live cables, manholes	436H	344
Testing structures, before climbing	433B	337
Tests:		
Circuits	424C	330
Lines	213	95
Theater switchboards, guarding live parts	335E	279
Thermal cutouts, automatic disconnection	324A	267
Third rail:		
Construction	289C	228
Cranes	380F	296
Disconnector	382C	298
Touching equipment	435E	342
Towers:		
Grades of construction	243A	159
Grades B and C:		
Flexible supports	260A6	179
Foundations	261B	180
Guys, use	261C5	181
Miscellaneous requirements	261A3	172
Strength requirements:		
Angles	261A3	171
General	261A	169
Longitudinal	261A3	170
Transverse	261A3	170
Vertical	261A3	170
Grade N	263A	204
Traffic, protecting	421H, 451H	321, 356
Overhead lines	433H	338
Transferring responsibility, tagged circuits	423I	329
Transformers:		
Arrangement	143	60
Grounding	142	60
Installation of	354	285
Instrument, grounding	141	60
Location	143, 286F	60, 224
Oil-filled, protection required	107B	60

	Rule	Page
Transmission machinery, guarding	112	42
Transmitting stations, rating	510B	361
Transverse loading, line supports	252B	164
Tree trimming	281	216
Trolley-contact conductors	261F, 263G, 289D	189, 208, 229
Tunnels	437	344
Two workmen:		
Testing	432F	336
Where required	422D	325
Unauthorized work, tunnels	437D	345
Underground, grounding conductors	93D	21
Underground lines:		
Bonding	295B	238
Buried cables:		
Protection at crossings	294B	237
Protection where parallel	294C	237
Separation	294A	237
Cables in conduit:		
Clearances	293C	235, 236
Identification	298	240
Live parts in manholes	296B	239
Location in conduit	293C	235
Protection against arcing	295A	238
Clearances:		
Buried cables	294A	237
Cables in ducts and manholes	293C	235
Duct lines	291D, E	231, 232
Risers from underground	297A	239
Conductor terminals	297D	240
Ducts	291	230
Location	290, 292H	230, 235
Manholes	290C, 292	230, 234
Risers	297	239
Unguyed poles, strength requirements	262A1	194
Uninsulated conductors (*see also* Bare conductors)	317	261
Under-voyage protection:		
Control equipment	329L	277
Motors	340D	282
Rotating equipment	120D	52
Unqualified workmen	411C	311
Unsafe supports	433D	337
Unusual conductor supports	280C	215
Utilization equipment:		
Approved equipment	302A	248
Future inspections	302B	249
Intent of rules	301B	248
Temporary or emergency installations	301C	248
Waiver for separate room	300C	247
Waiving of rules	301A	248
Ventilation, manholes	292D	234
Vertical loading, line supports	252A	164
Visitors	411C	311
Voltage limit:		
Appliances, portable	274A	291
Utilization equipment	300A	247
Waiving of rules:		
Equipment, supply	101	33
Equipment, utilization	301A	248
Lines, supply and communication	201C, D	94
Warning signs	280A3, 411H	213, 313
Warnings	420B	313
Employees	450A	349
Testing	432E	336
Watchman:		
Manholes	436D, 452C	343, 357

	Rule	Page
Wet places, hazardous locations, utilization equipment	307B	254
Wind loading, line supports	252B	165
Wire-crossing clearances	233	114
Wires:		
Method of connection	422H	326
Stringing	422J, 435F, 451G	326, 342, 355
Overhead lines	433J	339
Supply, approaching	435D	341
Wiring, illumination	156	65
Wiring, temporary, tunnels	437L	346
Wood poles (*see* Poles).		
Working alone	411B	311
Testing	432F	336
Working in elevated positions	430F	333
Working space:		
Clearances	115B, C	48, 49
Conductors	237C, 239A	136, 143
Dimensions	237B	135
Disconnectors, lighting arresters	181B	74
Location of buckarms	237D	136
Utilization equipment	305	252
Where required	115A	48